Your Construction and Operating QRP Sourcebook

QRP Quarterly

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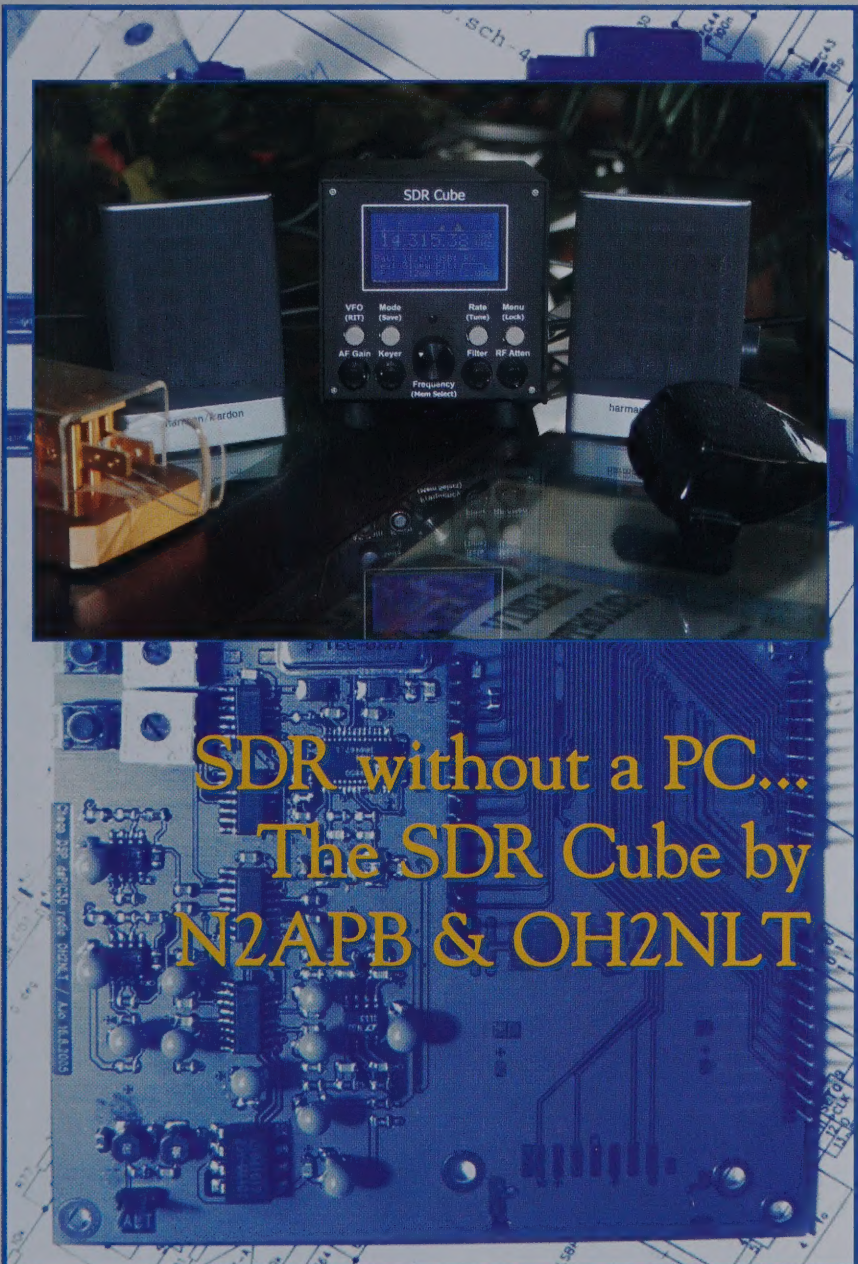

QRP ARCI℠ is a non-profit organization dedicated to increasing worldwide enjoyment of radio operation, experimentation and the formation and promotion of QRP clubs throughout the world.

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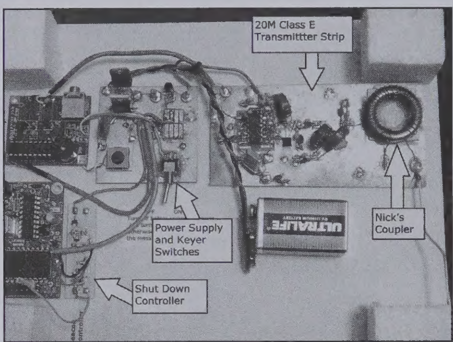

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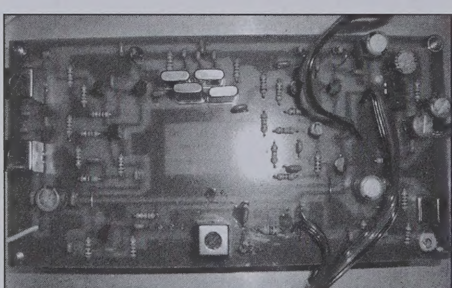

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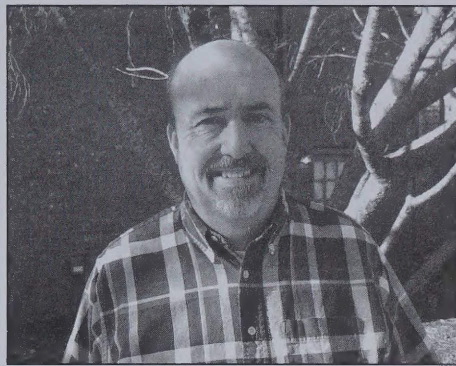
Technical Articles

The Joy of QRP

The World of QRP ARCI

From the President

Ken Evans—W4DU president@qrparci.org



QRP ARCI 50th Anniversary

Happy New Year! The year 2011 will mark QRP ARCI's fiftieth or Golden Anniversary. In 1961, we started out as a 100 watt club interested in reducing QRM, and have transitioned into a group of operators, hikers, builders/experimenters, contesters that pursue this great activity at five watts or less.

One way the club will mark this anniversary is to activate the club call in all 50 states throughout 2011. Some QRP ARCI members/volunteers will be assigned one week during the year in which they can use the club call, K6JSS from their state. We encourage them to operate with K6JSS as much with as many modes and as often as possible during their assigned week. A special "Worked All States" certificate will be issued to all that qualify.

The club needs volunteers to make this happen. We need one member/volunteer from each state. The member will agree to operate using K6JSS during their assigned week. They will also send a copy of their logs for the week to logs@qrparci.org. John Burnley, NUØV has volunteered to coordinate this effort for the club. He will work with volunteers to assign a week for their state and insure that the club trustee is notified. If you wish to volunteer, send an email to John at burnleyj@gmail.com. He needs your call and location plus any weeks during 2011 that are not good for you. I hope to see all 50 states on the air during 2011. Check the web site throughout this year for other 50th Anniversary activities.

FDIM 2011

It's time to start planning for the annual pilgrimage to Dayton on May 19 through May 22, 2011. We have a number of speakers signed up for the seminar and more are in the works. Details on the event, how to register for various activities as well as hotel room booking information are in this issue. Also, please check at http://qrparci.org/ for announcements as we get closer to May. I hope to see you at FDIM 2011.

Hank Kohl, K8DD (SK)

I am saddened to start this new year without one of our QRP Icons. We all took a great loss at 0530 on November 13, 2010, when Hank passed into the hereafter. Those of us who initially knew him through amateur radio remember a top notch CW operator, skillful traffic handler, DXer, contester, avid QRPer, member of the QRP Hall of Fame and a welcoming voice into amateur radio. Hank embraced all aspects of the hobby with enthusiasm and excitement. These attributes were evident when anyone walked up to a hamfest booth staffed by Hank. Many of us were welcomed into QRP by his friendly smile as you were greeted by Hank. When people would comment "Life is too short for QRP." Hank would reply with a smile, "Life is too short not to have fun with all parts of our hobby." He would then proceed to make a new friend and probably a new member of QRP ARCI.

He was hospitalized during the fall QSO party and not working him was an odd void—we always QSOed and Hank usually added something in jest like "power here is 5,000,000 uW". I cannot begin to imagine the QRP ARCI booth at Dayton without K8DD. That is where I first met Hank in the 1990s. Since then, I have had the pleasure to work with him on numerous club projects and make a life long friend. Hank was a doer—never complaining—and always positive.

As we got to know him personally, we found a good friend. My wife and I had the pleasure of traveling to the Isle of Man with Hank, his wife Kathy and best friends Stan and Trish Arnett, and Dick and Daphne Pascoe. Yes we played a great deal with radios, but I also got to see that Hank brought the same positive attitude to his

marriage and friendships. He and Kathy were thoroughly in love and their playful exchanges made it evident to all. Kathy has many positive memories that will sustain her in the future.

The club has lost a member of the Board, and a tireless worker. Someone will pick up his duties and carry on, but no one will replace him. I have lost a good friend and confidant. At Hank's request, there was not a funeral. Somehow, as I remember Hank, that seems entirely appropriate. He would want us to miss him, but celebrate his life by remembering a good friend and the good times. If today, we could somehow ask him how he was doing, I'll bet his response would be, "stupendous, fantastic, terrific, amazing, tremendous" ... That's Hank, always enthusiastic and positive. We will remember and miss you, my friend.

—72 OM,
Ken Evans, W4DU
President, QRP ARCI

QRP Hall of Fame Nominations

Members will recall that this is the time of year for the call for nominations for election to the QRP-ARCI QRP Hall of Fame. You can submit either real (postal) mail or internet nominations but they must include the following information:

- Name & Call of person nominated
- Name & Call of person making the nomination.

A full description of why you think your nominee should be in the QRP Hall of Fame HoF). Remember the voting body may not know this person and you must convince us the person is worthy. Things such as "John Doe is a great guy and always helps out at the club" will guarantee they will not be admitted. Be specific in your recommendation and try to persuade us as to why your person should be in the HoF.

The voting body consists of the QRP ARCI Board of Directors, the President, the Vice President and the eight most recent members of the HoF. Nominations may be submitted by anyone, whether a member of the QRP ARCI or not. Similarly, membership is not required for someone to receive the honor, since this is an award to recognize those who have made great contributions to the QRP community, not just to the QRP ARCI.

If no nominations are received, or the nominee(s) receive(s) less than the required vote two-thirds majority of the votes, there will not be an induction at Dayton for 2011. The BOD is adamant that it is not a requirement that we will have an induction each year.

Please forward your nominations to BOTH President QRP, president@qrparci.org, AND to the Vice President, vp@qrparci.org. Nominations in writing should be sent direct to Kathy Bromley and I at the following addresses:

Ken Evans, W4DU
848 Valbrook Ct.
Lilburn, GA 30247
USA

Kathy Bromley, WQ5T
3424 Brooken Hill Drive
Fort Smith, AR 72908
USA

The closing date for nominations is March 1, 2011. When a nomination is received, a confirmation e-mail or letter will be sent to the person making the nomination. If you nominate someone and do not receive a confirmation, we did not receive it. You will need to receive a confirmation to insure your nominee will be considered.

—Ken Evans, W4DU
President, QRP ARCI

Chuck Adams, K5FO (1998)	Rex Harper, W1REX (2010)
Brice Anderson, W9PNE (1996)	Wes Hayward, W7ZOI (1996)
Rich Arland, K7SZ (2002)	Dave Ingram, K4TWJ (2010) (silent key)
Dave Benson, NN1G (1999)	Doug Hendricks, KI6DS (1997)
Harry Blomquist K6JSS (2008) (silent key)	George Heron N2APB (2001)
Fred Bonivita, K5QLF (2007) (silent key)	Martin Jue, K5FLU (2009)
Michael Bryce WB8VGE (2000)	Bill Kelsey, N8ET (2004)
Wayne Burdick, N6KR (1998)	Ian Keyser, G3ROO (2004)
George Burt, GM3OXX (1996)	Hank Kohl K8DD (2007) (silent key)
Rick Campbell, KK7B (2009)	Jim Kortge, K8IQY (2002)
Jim Cates, WA6GER (1998)	Roy Llewellyn, W7EL (1992)
L. B. Cebik, W4RNL (1999)	Rick Littlefield, K1BQT (1996)
Arnold (Arnie) Coro, CO2KK (2003)	Tony Parks, KB9YIG (2009)
Mike Czuhajewski, WA8MCQ (1997)	Dick Pascoe, GØBPS (1997)
Tom Davis, K8IF (1996)	Randy Rand, AA2U (1992)
Doug DeMaw, W1FB (1992) (silent key)	C. F. Rockey, W9SCH (1996)
Ken Evans W4DU (2008)	Eric Schwartz, WA6HHQ (2005)
Rev. George Dobbs, G3RJV (1992)	Jim Stafford, W4QO (2010)
James Duffy KK5MC (2007)	Hans Summers, GØUPL (2009)
Joe Everhart N2CX (2000)	Gus Taylor, G8PG (1998)
Graham Firth G3MFJ (2003)	Steve Weber, KD1JV (2004)
Tony Fishpool G4WIF (2003)	Adrian Weiss, WØRSP (1996)
Dieter ("Diz") Gentzow, W8DIZ, (2005)	Peter Zenker DL2FI (2001)
Paul Harden, NA5N (1999)	

Members of the QRP ARCI Hall of Fame as of January 2011.

Iowa High Altitude Balloon Project

Terry Fletcher—WAØITP wa0itp@mchsi.com

The iHAB-2 beacon is an outgrowth of the beacon for the first iHAB balloon launch. That transmitter was a hurriedly thrown together combination of some left over projects, and new oscillator and buffer circuits. It worked, but I was unhappy with it's performance. Improvements were needed in keying characteristics, antenna matching, efficiency, and current consumption. The beacon transmitter described below addresses those concerns.

There are 5 main sections to the beacon, the transmitter, power supply/switch board, and the keyer, and DTMF controller. Figure 1 is a picture of the beacon's payload tray showing the layout and interconnecting wiring. This tray is one of several in payload container.

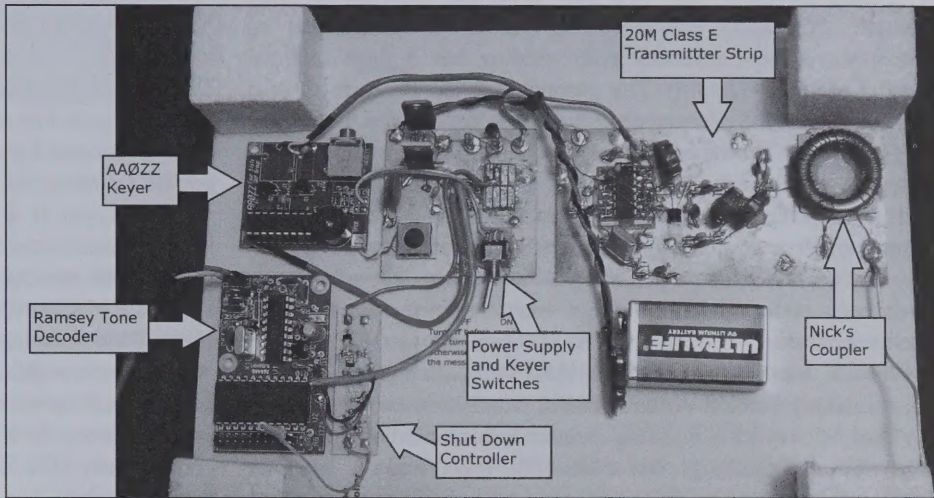


Figure 1—The iHAB balloon's beacon payload tray.

Let's start with the transmitter strip, Figure 2. This transmitter began life as a 40M Class E transmitter. David Cripe, NMØS, had been working on a slick little transceiver design and I built one of the prototypes. With his approval I scaled the final, and LPF components for 20M and it worked well. So well in fact, that the final operated at over 80% efficiency and stayed cool during a 2 hour key down test, figure 2 is the schematic. The whole system was tested by operating the whole beacon system for for 6 hours into a dummy load and the transmitter performed flawlessly. At that point it was deemed ready for the flight, or as the famous aircraft designer Burt Rutan likes to say "Mission Capable".

The initial output was 1.6 W into a dummy load with a 12 volts power supply. To save weight a 9 volt lithium battery was used and the output dropped to 1.2 W. it was a good trade off though, as 1.2 was enough, and the lithium eliminated a NiMH battery pack that was much heavier. Two hours into the flight the power drops to 1 W, as determined by bench testing, and it would have stayed at approximately 1 W for the duration. That was more than adequate, as shown by the huge number of signal reports on QRPSpots.com, the QRP ARCI web site. and the QSL cards received. As Ed Hare, W1RFI, and I like to say "One watt is a LOT of power." Especially when the antenna is so high.

The final amp is the ubiquitous 2N7000 operating in class E and matching 50 ohms out of the network. Figure 2 is the schematic of the transmitter. The 74HC02 Quad NOR Gate is a high speed device and is suitable for HF service. In this application it is configured as an oscillator and keyed driver. I was pleased by the keying characteristics. The old trick of running the oscillator constantly, and keying the driver worked very well. Pulling one of the inputs low turns on the gates, switching the output high, so a normally keying electronic keyer, straight key, or bug can be used. The low driver output the dots and dashes prevent the 2N7000 from conducting during that time, allowing it to run cooler. There was no attempt to shape the keying characteristics. At 1 W clicks were nonexistent and the slightly hard sound enhances the ability to be copied.

As mentioned above, the final's circuit was scaled from a 40M Class E design by David Cripe, NMØS, and no attempt was made to optimize the values. The calculations are easy, in doubling the frequency, divide the Ls and Cs by 2. While the drain waveform wasn't ideal, the final ran cool and the output after the LPF was clean. It's difficult to see in Figure 1, but the 2N7000 was mounted flat side to the copper clad using heat sink compound further enhancing cooling. The flight antenna is a half wave with no counterpoise, and it is neat to see 66 ft of wire dangling below the payload container at lift off. A half wave was

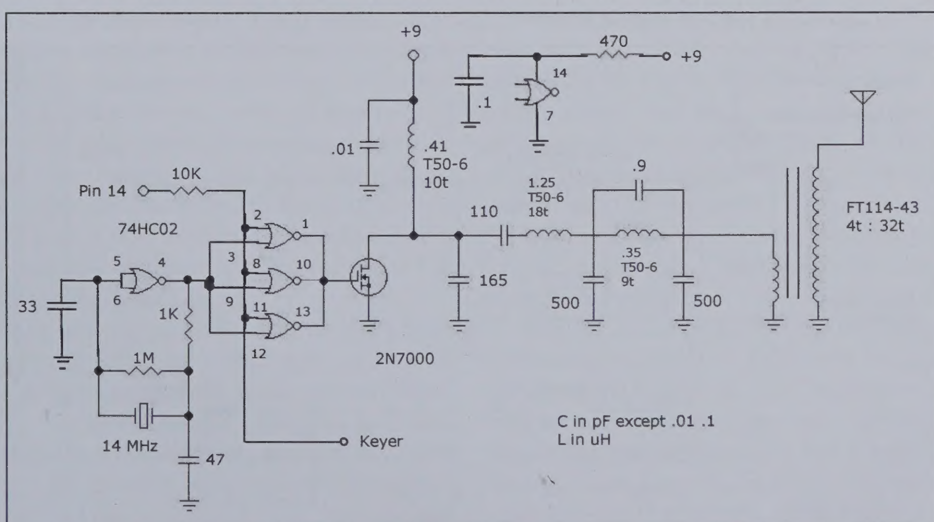


Figure 2—Beacon transmitter schematic.

chosen due to its high feed point impedance and less reliance on a counterpoise.

An unusual item in the transmitter is the antenna coupler. I call it "Nick's Coupler," and first saw it on the web site of Nick Kennedy, WA5BDU. It uses a FT-114-43 toroid, and is a step up transformer. The transmitter side winding has 4 turns and the antenna side has 32 turns. The rationale for the 1:8 turns ratio is that in practice the impedance at the end of an end-fed half wavelength antenna is on the order of 1800 to 5000 ohms (from Steve Yates', AA5TB, web site). So I chose a middle value 3200 ohms, and the impedance ratio of 1:64 does that. The 43 material provides enough reactance to prevent much loss through the core. I'm sure that the SWR isn't a perfect 1:1, but it's close enough. It may have been better to incorporate a matching network, but who knows what the impedance is at 87,000 feet anyway, HI.

Notice that the transmitter is built Manhattan style. While I enjoy making printed circuit boards, Manhattan construction is my choice for quickly building a circuit to test and modify. The IC was a bit of a challenge, but a little DIP board and magnet wire made short work of it. I glued the toroids to the board, as well as together, with hot melt glue because I wanted to assure stability while handling during the launch and when landing. Impacting the ground at somewhere around 1500 fpm can be quite a jolt if the landing site isn't soft ground..

The power supply board (Figure 4) is uncomplicated but necessary. Figure 3 is the schematic. Notice the reverse voltage protection method. Using a MOSFET to provide reverse voltage protection isn't a new idea. A PMOS device is used here because I had one in the junque box. An NMOS device could also have been used, provided it is connected backwards (source to +) in order to properly bias its internal diode for this application. The low on resistance of many MOSFETs yields a very low voltage drop, making it much preferred to the often used diode, IMHO, at about the same level of simplicity, albeit a little more expensive. In this case the drop is only a few millivolts compared to 0.2 or 0.5 volts across a Schottky or silicon diode. I first saw this idea used in a project by Paul Alexander, WB9IPA (SK). Paul was an excellent designer and fine ham and it's an honor to reference his work. In retrospect I think the PNP would have worked as well for the reverse voltage protection, but didn't think to try it.

A 2N4403 is used as a switch to shut down the transmitter in case of a malfunction. The base is switched by a command from the ground, and when it is grounded current flows to the transmitter. In retrospect I could have used a PMOS with a little more current capacity than the 2N4403, but this works well. It is adapted from the well known Vcc keying circuit by W7EL and publicized in EMRFD. A 5 volt regulator powers the EZKeyer, Ramsey DTMF tone decoder, and the toggle on/off flip flop SMD board. The two switches necessary to the keyer operation. So why is there an unused 8 pin DIP board? It was a failed experiment and I couldn't remove the board, the super glue was indeed super.

The Keyer is a slightly modified AAØZZ EZKeyer, and it keys the transmitter over and over and over and ... It is loaded with the beacon message, in this case "K6JSS iHAB 2" and some spaces. K6JSS is the QRP ARCI club call and was the call of Harry Blomquist (SK) the founder of QRP ARCI. Craig Johnson, AAØZZ, conveniently provided a beacon mode in the keyer code. In this case the message is stored in memory #2, and is sent by holding down the memory button, causing the contents to cycle continuously. The SPDT toggle switch performs the same function when aloft. The large push button switch is the command button. Only the paddle jack is used since is needed for programming, and the others weren't necessary to the mission.

Control of the transmitter from the ground is accomplished by DTMF tones from a 2M HT. Why is it necessary to incorporate beacon control in the design? The FCC says so—I think. Reading the regulations leaves me pretty sure, but not positive. Taken together, parts 97.109 Station Control), 201 (Auxillary Station), 203 (Beacon Station), and 213 (Telecommand) appear to require the ability to shut down any problematic station within 3 minutes of the problem occurrence, within 50 kM (31 miles) of the surface of the Earth. The station can be automatically controlled on 2M and below, and must have a photocopy of the station license, telephone number of the license, and a control operator posted in a conspicuous place. So to be safe, I incorporated a shutdown circuit controllable from the ground, and the paperwork is in place on the payload container.

Figure 6 shows the controller schematic and Figure 5 is a picture of the SMT flip-flop board that I produced. The input and output have been slightly modified from Dave Johnson's original circuit. Dave is the owner of DiscoverCircuits.com. and his circuit is used with permission. If you're a schematic junkie like I am,

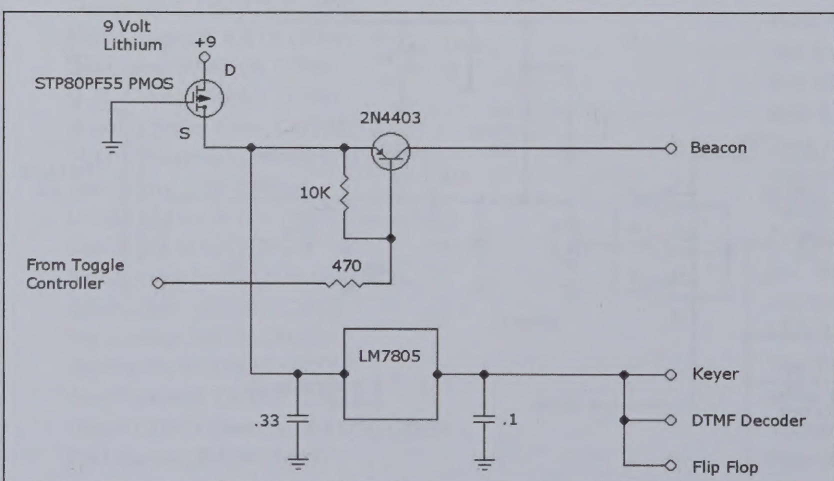


Figure 3—Power supply schematic.

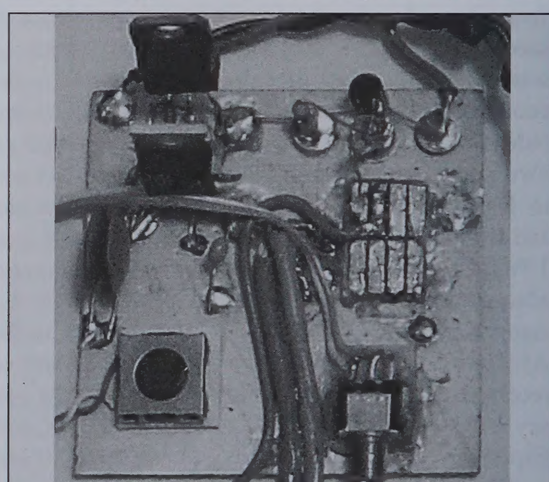


Figure 4—Power supply board.

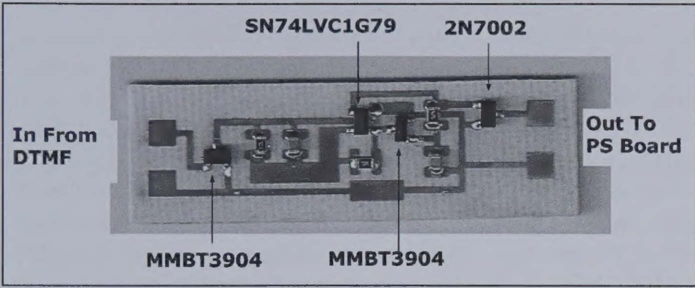


Figure 5—Controller flip-flop board.

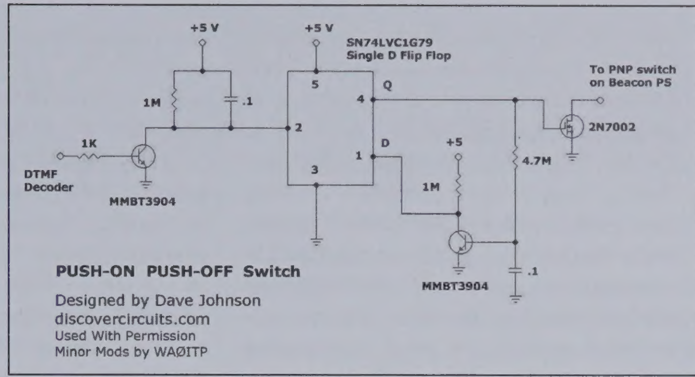


Figure 6—Controller circuit schematic.

www.discovercircuits.com is a wonderful place to spend some time browsing. I added an MMBT3904 at the input and a 2N7002 at the output. The Ramsey Tone Decoder is a good fit for this project, saved much time, and works very well. To control the beacon, an HT on the ground sends a signal with one of the DTMF tones to the airborne HT, and the audio tone then is passed to the tone decoder via the earphone jack on the HT. The tone decoder performs its function and sets a corresponding header pin low which triggers the flip-flop board. The flip flop output stays high until it receives another pulse before going low. So it toggles on and off as the HT on the ground sends commands, resulting in sending one transmission to turn the beacon off, and another one to turn it back on, if desired. The ability to turn it back on would be important in the event of an accidental button push of the controlling keypad.

What's in the future? The beacon work is over but the benefits linger on. The beacon will fly again soon, and probably many more times The transmitter design is a good starting place for a small transmitter, and the rock solid performance, small parts count, and good keying make it the logical choice for a good SMT Winter project. By the time you read this it should be on the air.

(This is being written on 20 Nov 2010) Working on this design fired my interest anew in Class E amps. Remembering Dave's presentation on Class E design at FDIM 2008, I created an Excel spreadsheet using the design formulas he presented. Using the spreadsheet is very easy and the resulting amplifier is easy to build and a rewarding performer. The spreadsheet is at: http://www.wa0itp.com Along the way somewhere during this project, I lost my fear of Class E amplifiers. The subject seemed so intimidating until I read Dave's article in *QRP Quarterly*, Summer 2009. I want to thank him for Elmering me through this project. He has the knack of explaining the esoteric to the untrained and making it understandable. That's more than a knack, it's a gift.

Please don't hesitate to send me an email if you have any questions about anything in this article, Ill do my best to answer them.

—72, Terry Fletcher, WAØITP

Editor's note—QRP ARCI provided sponsorship assistance for the iHAB project.

iHAB-2—How a Great Balloon Project got off the Ground

Marshall D. Dias WØOTM
w0otm@w0otm.com

In the fall of 2009, I stumbled upon a news story that was featured on CNN, FOX, and ABC news networks. The story was about a group of MIT students "seeking to share the artistic aspects of science" through "launching a digital camera into near-space to take photographs of the earth from high up above" in a project called Project Icarus. What made Project Icarus so interesting to me was the idea that anyone could design and launch a vehicle, and experience near space using only off-the-shelf components and a budget of $150 total. I quickly became fascinated with Project Icarus, and spent the following weeks reading the 1337arts.com website and watching hundreds of YouTube videos of others who had accomplished the same adventure. I decided that this was something I wanted to do!

Through my research, I discovered that something called APRS was commonly used in High Altitude Balloon launches, and in order to utilize the APRS technology; I needed to become an Amateur Radio operator. This is something I had thought about doing for many years, but was intimidated by the requirement of learning code. After contacting the only local ham operator I knew, I discovered that learning morse code was no longer required for Amateur Radio license. So, the following week I studied the question pool for the Technician License, and took my test in early October of 2009 at a nearby hamfest.

Through the winter months of 2009-10, I spent my time really enjoying amateur radio, learning about all the different facets of the hobby. Learning and gaining experience in VHF, UHF, HF, digital modes, CW, APRS, antenna design and RF propagation all proved valuable in the research and designing phase of what would become iHAB (Iowa High Altitude Balloon project).

Through the summer of 2010, I took aspects from everything I had learned from those YouTube videos and designed, built, and tested the payload for my first launch. It included a digital camera, redundant GPS tracking, and a HF beacon (built by WAØITP). In August of 2010 I gathered family, friends, and local hams to help me in launching the inaugural flight of the iHAB Project, iHAB-1. With no previous actual hands on experience in launching a high altitude balloon, actually launching iHAB-1 posed many challenges with lots of uncharted territory.

How do you actually fill a large balloon? How much Helium do we need? How do we know where it is going to land? We discovered we had more questions than we had answers to, but we figured we had thought through every possible scenario, all we could do was try it and see. iHAB-1 turned

out to be a huge success. With a total flight time of 5 hours 28 min, and traveling over 120 miles down range and ascending to an altitude of 84,400ft, iHAB-1 provided an invaluable learned experience, while confirming many design aspects.GPS Tracking, both APRS and cellular proved perfect, while the digital camera demonstrated there were areas of improvement. The iHAB team was overjoyed by the incredible response we received from the press, and amateur radio community. Amateur Radio stations from all over the world took part in the iHAB-1 launch and everyone couldn't wait for the next opportunity to launch iHAB-2.

On October 2, 2010 we launched iHAB-2. Thanks to the success of the iHAB-1 launch, QRP ARCI sponsored iHAB-2. The purpose of this mission was to take everything we had learned from the iHAB-1 launch and improve upon it. We needed a lighter, more streamlined payload, including better battery utilization, and improved digital camera performance. Terry, WAØITP, wanted to completely redesign the QRP HF beacon, reducing its physical size and weight, and decreasing its power consumption requirements. I needed to improve the overall vehicle design by eliminating unneeded weight by changing battery technology, different APRS transmitter, and digital cameras.

The payload for iHAB-2 consisted of a 12" × 12" × 9" foam box. This is the same foam box we used in the iHAB-1 launch as it proved to be a strong yet lightweight frame for our payload.I redesigned how all the electronics mounted by using corrugated plastic trays. Each component would mount to a respective tray, giving us a more modular design. The APRS tray utilized an OpenTracker+ and a high altitude GPS receiver creating the APRS packets for the Alinco DJ-C7—VHF/UHF putting out 300/500 mW and powered by its own built-in LiPo battery pack. A very simple 19" piece of 22 gauge speaker wire was used as the antenna which hung from the bottom side of the payload. The GPS and OpenTracker+ were powered by a 7.4V 2-cell LiPo battery pack. APRS telemetry was transmitted every 10 seconds.

In addition to the APRS GPS tracking, we also used a secondary cellular based tracker using a Boost Mobile prepaid Motorola i290, loaded with the InstaMapper java applet. InstaMapperis a free service that allows you to track a GPS-enabled cell phone online in real time. By utilizing cellular tracking, it provided a backup-tracking source at lower altitudes where APRS can often times be out of range.

Terry Fletcher, WAØITP designed and built the 20M HF beacon. The new design was smaller, lighter weight, and was powered off a lithium 9V battery. The transmitter put out 1.7 watts on 14.059 MHz, with 66 ft of 26-gauge magnet wire as the antenna. The antenna, like the VHF antenna, hung from the bottom side of the payload. The CW keyer is called an EZKeyer, which was also designed by Terry, and is available in kit form from the Four States QRP Group. The beacon was "K6JSS iHAB-2."

The main digital camera is a Canon PowerShot A480. It was mounted so that the lens would take photos out the side. CHDK (*C*anon *H*ack *D*evelopment *K*it) was used, which gave the ability to run a custom written script for taking photos every 10 seconds. CHDK is a firmware enhancement that operates on a number of Canon Cameras. CHDK gets loaded into your camera's memory upon bootup. It provides additional functionality beyond that currently provided by the native camera firmware.2 AA Energizer Lithium batteries powered the camera. In our previous testing it was determined that the batteries would last about 6 hours and 4000 images were stored to the 8GB SDCARD. iHAB-2 also included a second digital camera mounted straight up for taking video right after launch. We used the 808 Mini Car Keys Micro-camera, which are very popular on eBay. These tiny cameras are inexpensive, very light weight, and are powered with their own single cell LiPo battery. Weighing in at about 45 grams, they worked perfect. We got 45 minutes of video, which provided a very unique perspective of the launch.

The iHAB-2 payload weighed in at 1232 grams, 400 grams lighter than the iHAB-1 payload. The total launch weight was 1254 grams, which included the parachute, separator ring, and respective rigging. A Kaymont 600 gram balloon filled with 75.74 cu/ft of helium provided 1601 grams of neck lift. Neck lift is the force the balloon neck has upwards, before any payload is attached. The difference between launch weight and neck lift, determines the ascent rate. Like in the iHAB-1 launch we stayed with a projected 3 meters per second ascent rate.

We launched iHAB-2 from the Ottumwa Industrial Airport at the Indian Hills Community College North Campus Aviation Building at 1400Z. The surface winds were higher than we had wanted, and the winds aloft were very consistent with fall weather in the Midwest. The weather reports and flight modeling software had predicted a flight path to the southeast, landing east of Quincy, Illinois. The HF beacon performed superbly; within just a few minutes after the launch signal reports began coming in at qrpspots.com. The winds aloft were near 75+mph, so once the balloon gained some altitude, it quickly picked up speed. The APRS tracking provided constant telemetry to the chase vehicles as we headed toward the predicated landing site. Around 1 hour into the flight, the balloon had exceeded 80 mph and had gotten ahead of the chase team. There was no way we were able to keep up with it as we drove down the interstate. Higher than predicted winds aloft and a slower ascent rate than planned took iHAB-2 further southeastward than we had planned.iHAB-2 reached a burst altitude of 87,100 ft, flew for 4 hours 21 minutes, and traveled over 200 miles downrange. iHAB-2 landed in a freshly plowed cornfield east of Rockbridge, Illinois. Cellular signal and APRS coverage were nonexistent in the rural parts of Illinois, so thanks to the help of a few local fox hunters—Mark Joseph KC9DUU, Jesse Risley K9JLR and Jeremy Lamb KC9KGJ—the iHAB-2 payload was located the old fashioned way.

Over 300 signal reports were received from all parts of the world, 4000 photos were taken, 48 minutes of digital video, and hundreds of people, including the iHAB Team, were ecstatic with the success of this flight.

So whats next for the iHAB Project? Aside from many more iHAB launches, we have created a classroom program called CanisterLabs. A CanisterLab is an experiment that fits inside of a plastic 35 mm plastic film canister. Think big by thinking small. The CanisterLab program is designed to get students, researchers, engineers and people everywhere to be directly involved in science and space. These film canister "laboratories" are flown to the edge of space by the iHAB Team. The purpose of this program is to provide a vehicle to "launch" creativity into nearspace.

You can learn more about the CanisterLab program and the iHAB Project at www.ihabproject.com. ●●

Idea Exchange

Technical Tidbits for the QRPer

Mike Czuhajewsi—WA8MCQ wa8mcq@verizon.net

In this edition of the Idea Exchange:

Daily Notebook (Quickie #76)

Joe Everhart, N2CX, normally presents technical topics in his endless stream of Quickies. Unfortunately he was unable to cover the one he had originally planned since it would take more effort than could be done in the time available. Instead he presents something which is perhaps a bit boring but very important, and which I suspect a lot of us don't do. That is keeping good, detailed and organized records of all of his ideas, experiments and projects. I know I fall down badly in this area, with hundreds of pages of somewhat cryptic experimental notes scattered all over the house, with no organization whatsoever. Joe has a better way, shown here in Quickie #76.

If your head is like mine it's always brimming with ideas. The challenge is to corral the "mindstorm' and capture those fleeting thoughts. We all probably scribble notes to remind us of a brilliant thought but by the time we get around to reading those fragmentary snippets they don't always make sense. I've found that the way to keep things more or less under control is discipline—not that I'm always that organized. The discipline in this case is to distill those odd scribbles into a daily notebook. This Quickie will describe the process I use to rein in my metal chaos at least as far as technical ideas go; literary and personal info is a whole other matter entirely. My scheme will likely seem droll and mechanistic but hey, it works for me…

Lots of very organized folks keep diaries to record their personal thoughts and my notebook is kind of a cross between a diary and the written lab notebook that techie types keep. I try very hard to force myself to organize these technical and project ideas into daily files stored on a computer. That way I always know how to find them—except in times of extreme disarray, it's hard to lose a big box like my computer.

Structure of the daily files is important too, as is how they are organized on my computer. First off I'll describe the daily file content and later how they are organized on my computer.

Prosaically enough each entry is one DOC file named "Daily Notebook YYYYMMDD.doc". I use DOC type files so that they can be read on any of my computers using either Microsoft Word or the open source (and free!) OpenOffice program suite. Dating using the above date format is important since it makes sorting and structuring file directories easy and clearly indicates when the entry was made. YYYYMMDD is simply the four digit year followed by a two digit month entry and a two digit day entry. Using all of the digits is important since computers unambiguously sort on that number string.

An example of one entry is shown in Figure 1. It is a daily notebook file for November 13, 2010 with the file name "Daily Notebook 200101113.doc". Inside the document the first line is always the guts of the file name identifier so I can't forget what I'm working on. The second line is a wrinkle I picked up from a very disciplined co-worker some years back. He kept a daily journal on his computer to document his literary, personal and business ideas. So that he could easily keep track of his ideas he always extracted some key words to succinctly describe the content of each daily journal entry. I'll describe later how these keywords will be used.

Contents of the daily files generally keep the format shown. The contents are a brief summary of the idea or ideas of the day. It is extracted from the day's pack of sketchy handwritten notes with only enough detail to make it understandable in the future. If necessary it will also include a sketch either scanned from a handwritten version or pasted in from some drawing program or even a photograph. And if the idea is in an interesting book I run across, a magazine article, a web page or a new store, I'll jot down enough reference info to find it later.

The idea is not to develop ideas or concepts but to take a quick snapshot of them for future reference. My usual practice is that when I decide to flesh out an idea I expand from the notebook and document more fully in a computer file named for that particular project. In fact this Quickie began as a daily note outlining my notebook method then became a dedicated project folder once I started writing in depth.

Not all of the daily notebooks have extreme detail. Figure 2 shows a small snapshot of an idea for future development from November 18. It contains the usual header info along with a short description of the brainstorm and a reference to be used whenever I get back to it.

Once the daily entries are made, yet another part of the discipline is to organize the files and their content for looking up at a later date. Figure 3 illustrates a concept of how it's done on my computer. For brevity it has only a couple of entries for explanatory purposes. There is an overall file called—what else—Daily Notebook 2010 containing all of the individual entries for the year. Under that are subfolders for each month with a title in the format

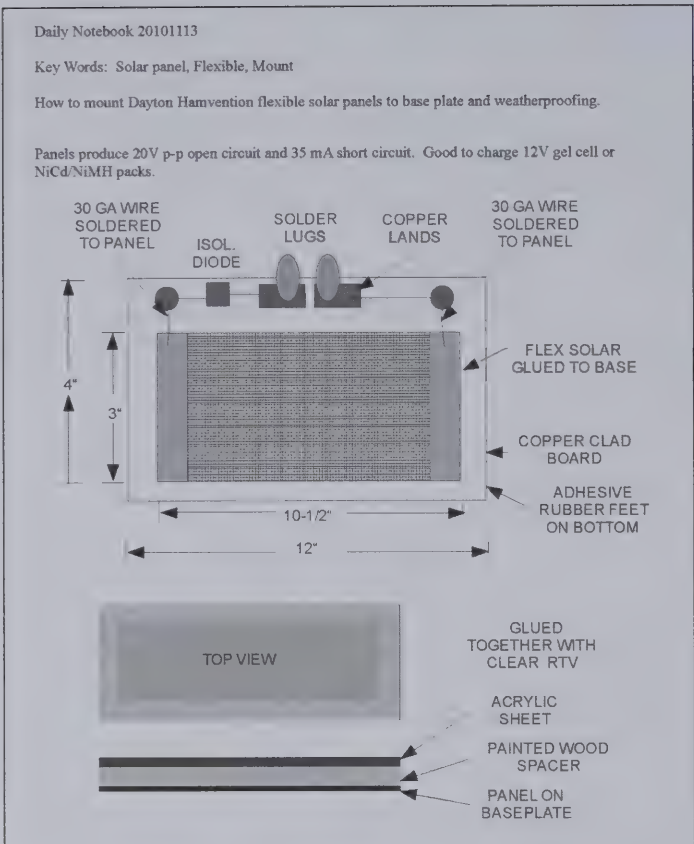


Figure 1—Example of a daily notebook entry.

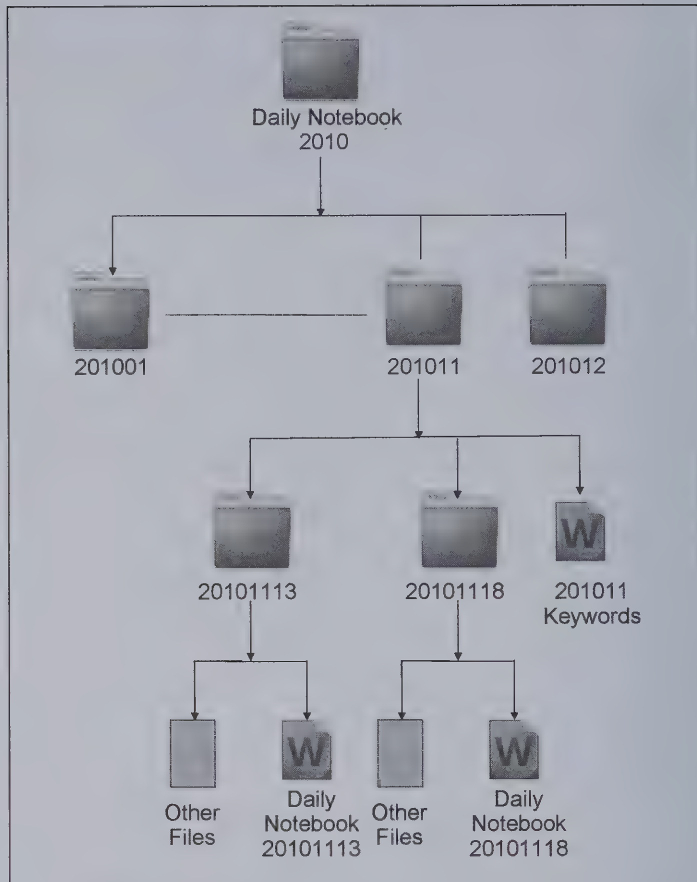


Figure 3—File organization method for the daily notebook system.

Daily Notebook 20101118

Key Words: LTSpice, SWR, Ant Analyzer, EFHWA, 3rd method. M0AJL

Idea is to model circuits using LTSpice and insert resistive SWR bridge to evaluate SWR.
With bridge fed by RF source and circuit to be modelled as load can easily measure SWR to verify matching, BW etc.

1st use under consideration is 3rd method of matching EFHWA per SPRAT Antennas-Anecdotes

REF: THE M0AJL MULTI-BAND VOLTAGE FED ANTENNA, M.A.EALES
SPRAT 97, p. 28

Figure 2—A much less detailed notebook entry.

Keywords 201011

20101113: Solar panel, Flexible, Mount
20101118: LTSpice, SWR, Ant Analyzer, EFHWA, 3rd method, M0AJL

Figure 4—Typical monthly keyword file.

2010MM. Each of these holds files for only that month of the year plus a DOC file listing keywords used in that month. Finally at the lowest level are the daily folders. Each has the daily entries as illustrated in Figures 1 and 2 and sometimes, when needed, some supplementary reference articles or documents too lengthy to include in the notebook documents.

The monthly keyword files entitled "Keyword YYYYMM.doc" are important in providing the means for quickly finding a given topic. The abbreviated file for November 2010 is detailed in Figure 4. The contents are very simpleminded. It's a simple list with one entry for each date with a notebook file and the keywords used on that date. This format greatly simplifies finding on which date a particular topic was used.

I hope that describing my way of organizing ideas has been useful to you. It is admittedly quite nerdy and dry. However without it I'd never be able to keep track of all my Quickie and project ideas. Perhaps you can adapt this method or something similar so that your nerdy right brain can keep track of the Scathingly Brilliant Ideas that your creative left brain conjures up!

—de N2CX

Check Your Soldering Iron Today

This reminder posted to QRP-L a while back by Paul Signorelli, WØRW, could keep someone from damaging components during soldering—

Today is "National Check Your Soldering Iron Day". Before you do any more soldering, you should check your iron for leakage currents. An ungrounded soldering iron can damage components. Plug it in and measure from the tip to ground with a multimeter; use your ESD (electrostatic discharge) ground or whatever your equipment is grounded to. Check with the meter set for both AC and DC voltage.

If you are above 1 volt you should ground your iron tip. (Of course I know DoD Standard 2000 and the ESD association use different minimum levels.) You

can add a ground to your soldering iron by using a spring clip or some other non heat conducting wire. If you get sparks when you touch the iron tip to ground you had better throw it out and maybe get a GFCI (ground fault current interrupter).

While you are at it, if you have one, also check your ESD wrist strap ground with an ohmmeter. You should have about 1 megohm from your wrist strap to your ESD ground.

Paul later sent the following additional comment by e-mail—

We once had a failure of a spacecraft unit that was being built up on the assembly line. The failure was caused by an ungrounded soldering iron; it blew up a transistor. The iron had a "green wire" ground connected to the AC outlet but the bezel plate was broken, which allowed the ground pin to disconnect when the AC cord was pulled to the side. After that, all soldering irons had a redundant hard wire ground on them.

—de WØRW

A Simple Transmitter Test Set

Steve Ray, K4JPN, sent this along recently—

I built the basic design of this test set long ago, to work on my HW-101; over the years it has been handy for many rigs. I recently modified it to incorporate a –20 dB coupler for a low level RF sample. (The coupler design came from the Spring 2008 *QRP Quarterly*.) While there is nothing new about anything in this gadget, it sure makes it easy to hook up stuff as it is all combined into one unit.

The basic idea of the test set is to build in an RF voltmeter, and a sense line for the RF output. A switch allows the rig to be connected to either a dummy load or antenna. Figure 5 shows the schematic, and Figures 6 and 7 show the unit.

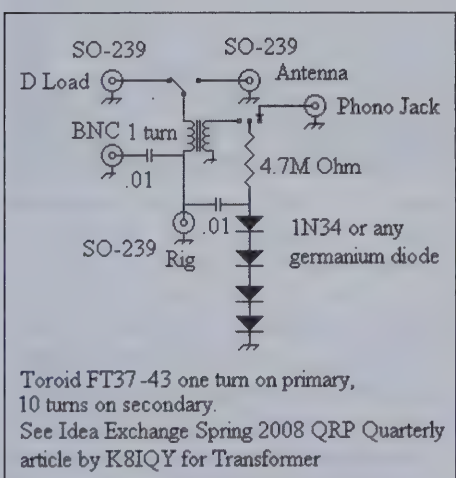


Figure 5—Schematic of the test set.

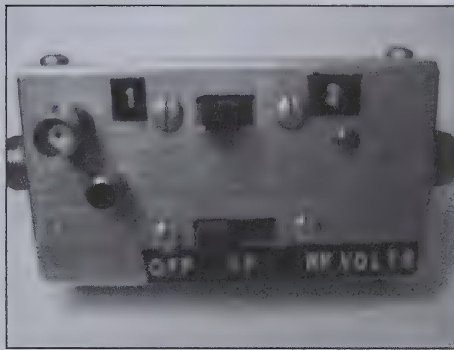


Figure 6—Front of the test set. Switch positions 1 and 2 select the dummy load or antenna. The 3 position switch for the phono connector selects the –20 dB RF sample or diode detector output ("RF volts").

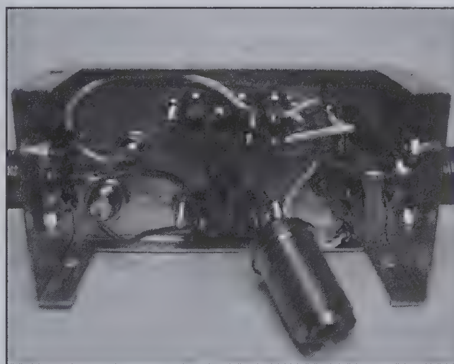


Figure 7—Inside the test set. The single hole SO239 socket in the middle mounts on the cover.

The operation is simple; just connect a VTVM to the RCA phono jack with the switch in the RF voltmeter position. Since this unit was built to handle 100 watts I used a string of germanium diodes to withstand the peak voltage, so the RF voltmeter portion is more of a relative indication, than an accurate, absolute one. It is ideal, however, for neutralizing tube rigs and adjusting SSB rigs for minimum carrier. I prefer doing this with an old analog 11 megohm VTVM, rather than a digital voltmeter.

It should be obvious from the schematic that the BNC connector is full output and the switched outputs to the RCA phono jack are for a 20 dB down sample and the RF voltmeter.

—de K4JPN

Simple Reverse Power Polarity Protection

Paul Signorelli, WØRW, later sent this along by e-mail—

There are a lot of rigs out there that cannot tolerate power line reversal (red <—> black); you can easily blow your rig up by reversing the positive and negative power wires. Reversing power wires to poorly marked batteries can be very easy to do and very expensive. If you are using red and black clip leads to connect your radio to a battery, you need to add protection for your rig. If you have a fool proof connector system you don't need to do this, but if not, here is what you need to do.

The older rigs like the Heathkit HW7 have no internal diode protection. The next generation of rigs like the TenTec Argonaut 509 have a parallel shunt diode right after the fuse. If you apply reverse voltage the diode conducts and blows the fuse, thus protecting the radio.

That design is OK and they used it because it doesn't have any series voltage drop and because they didn't have Schottky diodes then. Some of the newer rigs have a reverse diode but they are located after the input aluminum electrolytic bypass capacitor. That component can blow up and make a big mess in the radio. The main radio guts may be saved but it can blow that capacitor apart.

The easiest way to prevent this damage is to add a series Schottky diode in your power cord or right inside your rig. The Schottky diode has a poor reverse voltage rating, but has a great, low forward voltage drop (V_F) rating. The V_F is typically 0.4 to 0.6 volts and the low reverse rating doesn't matter in a 12 volt system. The most popular Schottky diodes are 1N5817, 1N5818 and 1N5819, all rated at 1A forward current. [*The continuous reverse voltage ratings are, respectively, 20, 30 and 40 volts. —WA8MCQ*] The NTE585 is a suitable replacement for the 1N5819.

If your rig draws less than 1A you can use one of these. They are perfect for the HW7. The 1N5820, 1N5821 and 1N5822 are 3 amp diodes (20, 30 and 40 volts) and can be used with 5 watt rigs. (The ratings of the NTE586 are the same as 1N5822.)

There are many others in TO-220 packages, like the MBR745 (45 volts) that can handle 7.5 A but may have to be heat sinked. [*Originally made by Motorola, the MBR745 is currently manufactured by sev-*

eral companies, including ON Semiconductor, a division spun off by Motorola many years ago. —MCQ]

So take the time to check your rigs schematic and see if the design is adequate. If not, add the reverse diode protection. You will never know the amount of money you will save.

(The PRC319, KX1, and Wilderness Sierra all have built in reverse protection diodes.)

—de WØRW

Toroid Wire Twister

Bifilar and trifilar wires are often used when making transformers with toroid cores. There are many ways of twisting the wires together, such as chucking them in a drill, but here's an elegant and very simple solution for making the wire bundles. This was posted to the BITX20 discussion forum on Yahoo.com in 2004, but I never noticed it until 6 years later. This is from Arv Evans, K7HKL—

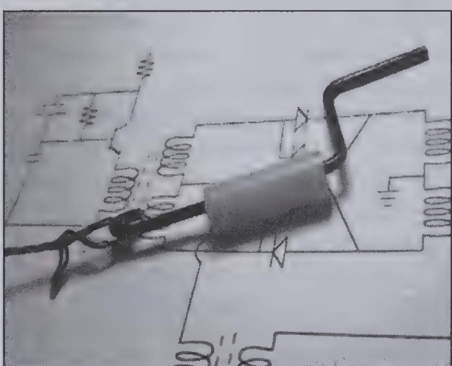


Figure 8—A simple tool for twisting wires for toroids.

Twisting the wires together for winding trifilar inductors is made easier with a simple tool built for that purpose. Figure 8 shows my "Trifilar Twister Tool".

I made this using a 1 inch long section of plastic tube (3/8 In. OD by 3/16 in. ID) and a stiff section of wire. You can build this using material at hand.

Operation involves securing the far end of your wire so that it will not twist. Then connect the near end of your wire to the twister tool. By holding the bushing and turning the crank handle you can control the tension, count the turns (turns/ length = turns per unit length), and make a very clean looking double, triple, or quadruple wire for winding on toroid forms.

Arv later supplied these comments by e-mail—

It came about because I was thinking about the original BITX20 concept of being something that 3rd-world builders could construct from junk-box parts, hence the hand-cranked wire twister seemed to fit. It is also much easier to count turns if you are doing it manually instead of with an electric drill. Say you want 8 turns per inch; just measure the inches of wire and crank the handle 8 times around for each inch. The wire came from a coat hanger and the plastic was a nylon stand-off. I can see someone making this with just a stick with a hole in it and a stiff wire crank.

—de K7HKL

WA8MCQ note—The BITX20 is a QRP 20M SSB transceiver designed by Ashar Farhan, VU2ESE. There is a discussion group dedicated to it on yahoo.com, and details on the project can be found on www.phonestack.com/farhan/bitx.html. Kits for 20M and 17M, based on the original design, are also available from Hendricks QRP Kits, www.qrpkits.com.

Making a Manhattan Construction Island Cutter

Just about everyone knows what Manhattan style construction is nowadays, and a variation on that is cutting isolated islands in the copper instead of gluing down pads. Mauricio Mezzera, KG6MFT, passed along these instructions for modifying a Dremel cutting tool to make the islands—

If you want to do a project on a weekend but don't have time to do a nice PCB you can go with Manhattan or "ugly" style. What I don't like about Manhattan construction is cutting out pads and then gluing them on a piece of copper clad board. The New Jersey QRP Club used to have an island cutter for isolating spots of copper on the board itself, but it is no longer available.

Since I really liked the idea, a search for a similar tool started. I found that the Dremel high speed cutter #115 (Figures 9 and 10) was close but needed work. Since I had been a dental technician for 40 years I have all sorts of cutting and grinding things. It was easy to use a diamond burr on a high speed hand piece to hollow out the center of the Dremel cutter until there was enough clearance from the bottom to the rim of the cutter (Figure 11). You don't need much; it will cut just the thin copper, leaving an island of approximately 5 mm diameter.

Figure 9—This is the package to look for to make your own island cutter.

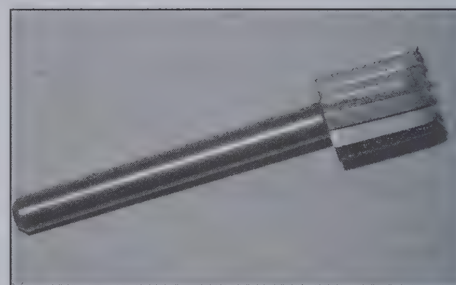


Figure 10—The Dremel #115 cutter needs just a bit of modification to become an island cutter.

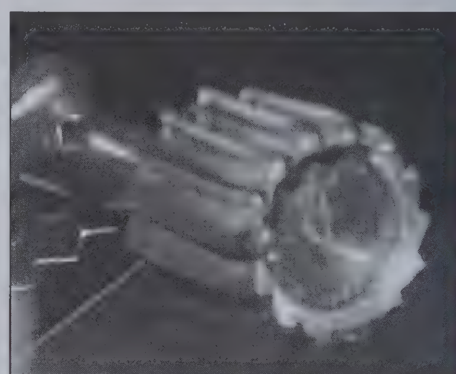


Figure 11—Hollow out the center to make a ring cutter.

Mount the #115 cutter on a drill. Mount a carbide cutter or a brown grinding stone on the Dremel tool. Turn both machines

Figure 12—Dremel tool mounted in a drill press.

Figure 13—Islands cut in the PCB with the modified cutter.

on. While the cutter spins on the drill, start working with the Dremel until you complete the job. Carefully try to obtain a moderate rim, not too thin, so you will have good isolation between the island and the surrounding ground plane.

You have to use a drill press to avoid "walking" of the bit when cutting islands. The one in Figure 12 is from Dremel, and Sears carry its own brand but it is identical. To the right is a dimmer I use with the drill press for speed control; the rest of the time it's used with my soldering iron. Figure 13 shows the resulting isolated islands in the copper after using the tool.

—de KG6MFT

Thoughts on Lubricants and Electronic Equipment

A while back there was a thread on the HP/Agilent discussion forum on Yahoo.com which started out being about WD40, the popular, multipurpose petroleum based product. Dave Baxter, GØWBX (G8KBV) had these comments—

As a part time mechanical type, and full time fixer of many things electrical, electronic, electromechanical, from low level/small signal RF to multi-kW RF amps and HV power supplies, etc, this I've learnt over the years, much from painful personal (and sometimes expensive) experience.

Take great care choosing and using *ANY* lubricant, easing fluid, solvent cleaner, etc., on any electrical equipment, especially RF or high voltage.

True, oil, "gas" (petrol to us Brits), diesel fuel, engine oil, etc., and some solvents do not conduct electricity, but....

All lubricating "stuffs" will do the job well, however, eventually they will spread out if not sealed in, collecting dust and dirt. It's that that causes later trouble, in turn allowing moisture to accumulate, causing tracking, leakage, corrosion and other woes.

Solvents (all penetrating, and many lubricating oils, contain them in one form or another) can attack many plastics, or seep into other materials, switch and tube base insulators for example, changing (for one) their dielectric properties. And not in a constant way, so many RF trimmers, for example, will need adjusting forevermore to keep whatever instrument in trim. And when dirt is retained, and hence moisture on the dirt, more leakage/tracking troubles can appear, especially where there is "some voltage" involved.

Attacking plastics is often instant and irreversible, so is obvious, but it can also take time, a long time to happen, so you lose the connection as to why and what caused it!

All mineral oils and derivatives will attack anything made all or in part with natural rubber. Depending on the exact nature of rubber and oil, it can be near instant, or take a long time.

Silicone lubrication is less damaging than some other types, but it does still creep and spread all over the place, and just like the others, with the same dirt collecting properties. But it is so much less damaging chemically to other materials, as far as I know.

For variable caps (tuning types) yes, if you can strip them down and clean out bearings etc, great. But keep the lube to the absolute minimum needed to prevent seizure, and keep it away from the plates themselves. Any attracted dirt on them will affect the capacitance, and also lower the breakdown voltage.

As to conductivity: Here at the salt mine, we use a refined mineral based oil as a coolant that is pumped around high power tube type amplifier stages, where it is in full contact with up to 2 kV DC and many kW of RF, kHz to hundreds of MHz. Other than intermittent oil leaks where plastic tubing and O-rings creep over time (or melt if someone did something stupid too many times!) there is no detrimental effect, and no conductivity issues. Even if the user lets things get too hot, and the oil starts to break down into sludge over time, there is still no electrical conductivity trouble. Moisture contamination (condensation inside the header tank) though, can make the oil turn a nice shade of blue or green, and become mildly conductive.

De-ionized water will do the same; pure water is an insulator after all (it's also actually the best coolant, specific heat wise) but over time gets contaminated and becomes conductive, resulting in electrolytic corrosion and pin-hole leaks everywhere.

The very worst thing to do is to "lube" cam operated small signal leaf switch contacts. That will lead to eventual permanent death of that instrument. As if damaging the plastic cam isn't bad enough (if it isn't worn already.) Those switches are supposed to be dry, but if the gold flashing wears out (as it can) you need to replace the springy leaf part, and position the "new" part so it acts on a fresh part of the "land" on the PCB, that still has it's gold plating.

It's not easy to do, needs great care plus good eyes and a steady hand. Certain analyzer front end attenuators are a real pain in this respect, as their design does not easily allow the repositioning of the switch leaf contacts in this way. Of course if you do that, the matching at GHz frequencies can change too. Swings and Roundabouts as we'd say...

Likewise, if a potentiometer is noisy, it's the beginning of the end. Lubing it only

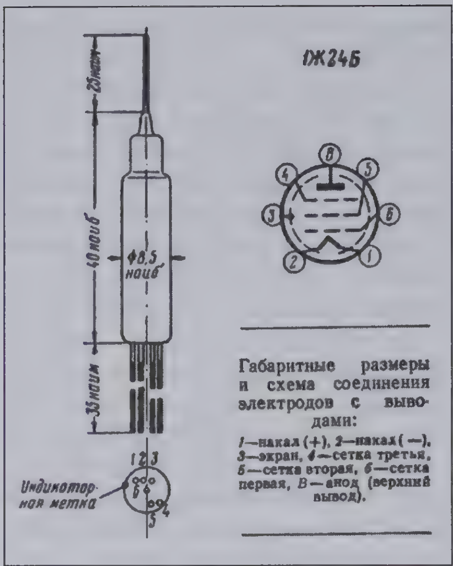


Figure 14—Tube description from a Russian tube manual.

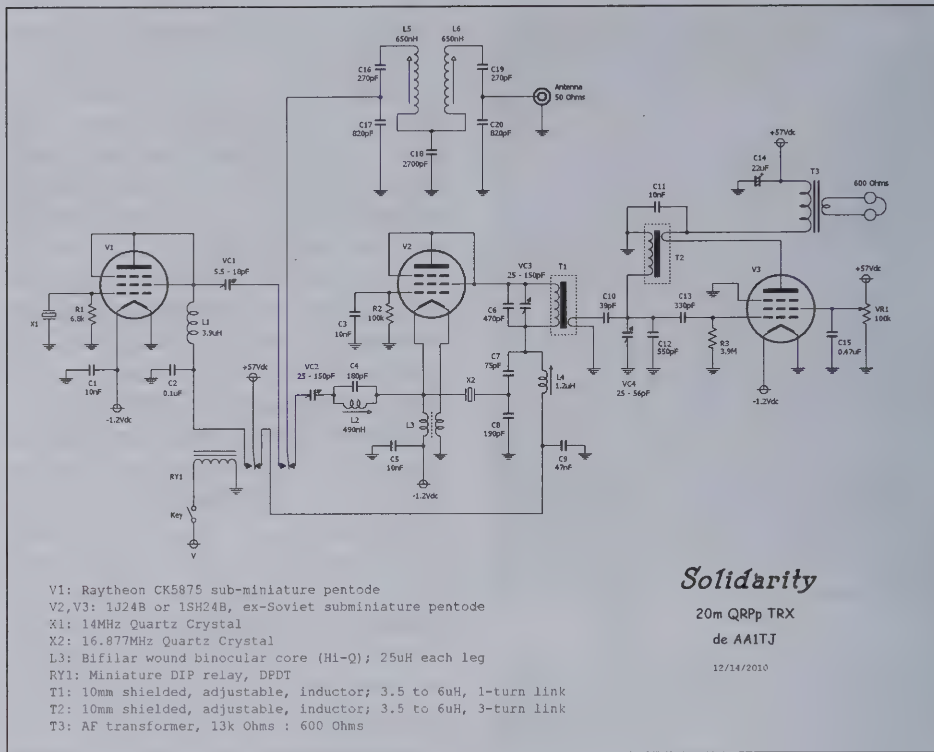


Figure 15—Schematic of the pencil tube rig.

puts off the inevitable, and can also (due to dirt attraction, and ingress into the track substrate) cause more problems than just a noisy pot! Some older types you can dismantle, clean and adjust them (the wiper to a less worn part of the track). But just squirting stuff inside, though it may effect a seeming instant fix, won't in reality cure them; the noise WILL come back.

Just my take on the issue, doing all this for a day job, and as a hobby too, for more years than I care to admit. I sometimes think a career digging holes in the road would have lead to an easier life! At least you can hide your mistakes, and problems (managers) deep underground!

—de GØWBX (G8KBV)

Pencil Tube DX with "Solidarity"

Many of you are probably familiar with the old pencil tubes, so called due to their small diameter. You may have even seen occasional articles about people building modern QRP rigs with them. Mike Rainey, AA1TJ, posted this article to his online blog about his pencil tube rig, which he named Solidarity. (Ref. 1.)

The receiver used in Solidarity is an upgrade of that used in my November 27, 2010 station (Ref. 2). The detector now operates in the vicinity of 2.87 MHz with improved frequency stability. Furthermore, the addition of the frequency converter stage introduces isolation between the detector and the antenna.

My earlier receiver was also plagued by microphonics. While a vibration damping mount for the CK5875 detector tube would have greatly reduced the problem, I decided to side-step the issue entirely by switching to a remarkable, Soviet-made subminiature pentode.

The 1Ж24Б (1J24B, 1SH24B) is a marvel of ingenuity dating from the 1950s. Examining the close-up photos on the German web site in Ref. 3, one might be tempted to exclaim, "Where are the grids?" In fact, three grids are present, only they aren't helically wound, neither are they ladder or screen structures; they're collinear! This device is the product of some clever electron optics (see Ref. 4) involving tiny sheet beams.

Another virtue of this tube is its extraordinary emission efficiency (Ref. 5); a definite plus given my eventual goal of building a minimalist's vacuum tube-based portable QRPp station.

Details of the 1Ж24Б are covered in a 1962 Soviet vacuum tube manual (Ref 6); see Figure 14. An article on the topic of these tubes appeared in the July 1960 edition of the journal, Радио ("Radio"). The article begins on page 34, which is page 40 of the scanned document. See Ref. 7 for instructions on downloading it.

Aside from the vague speculation that they may have been used in the MIG-25 FOXBAT fighter (Ref. 8), it's clear these tubes were used for portable military equipment of the Warsaw Pact nations, an example of which may be found in Ref. 9. They were used for similar applications, and during the same time period, as the likes of my Raytheon subminiature tube, which was used in NATO equipment.

I rather like the idea of melding the CK5875 and 1J24B—these former Cold War adversaries (Ref. 10)—into a single radio. Figure 15 shows the schematic, and Figure 16 is the actual rig.

The 40 mW transmitter amounts to a simple, crystal controlled Miller oscillator followed by a high-pass L-network for impedance matching. For maximum efficiency L1 needs to be a Hi-Q inductor.

The regenerodyne receiver IF tunes from 2.877 to 2.807 MHz in order to provide 20 meter coverage from 14.000 to 14.070 MHz. L2 and C4 constitute a 16.877 MHz trap filter. Adjust L2 for maximum 16.877 MHz energy at the filament. VC2 cancels the residual trap reactance at 14 MHz. On paper it improves the sensitivity by 4 dB; it's not strictly necessary. While tuning across the band VC3 needs to be re-peaked every 10 kHz or so. VC4 is the main-tuning variable capacitor and

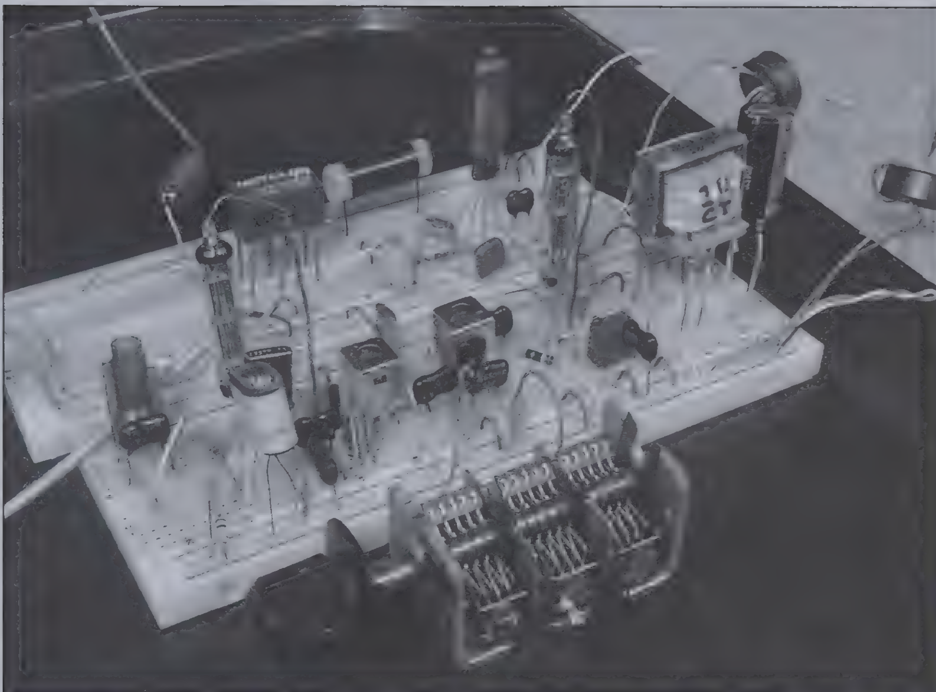


Figure 16—Solidarity, the pencil tube rig, built on a protoboard.

VR1 is the regeneration control.

The CK5875 filament draws 100 mW at 1.2 VDC and the 1J24Bs each draw 15 mA. Altogether, the receiver only consumes 217 mW of input power. Not a peep of shortwave broadcast interference has been heard on this receiver in several weeks of operation.

Despite poor band conditions in early December, Solidarity provided me with several pleasant QSOs. K9IS replied to my CQ with his Elecraft K1 from Wisconsin. Steve was running 3 watts to a dipole. He was 579 on the regenerodyne and he gave my 40 mW signal a 339 report.

An hour later N4KGL/4 answered my call. Greg was operating his little Wilderness SST radio at 3 watts into a Hamstick dipole that he mounted atop a 20' mast. He was on his lunch hour and operating from the parking lot adjacent to his office.

Working a guy standing in a parking lot on his lunch hour (a stone's throw from the Gulf of Mexico) with 40 mW and some vintage pencil tubes stuck in a plastic protoboard here in snowy Vermont is just plain cool!

These great QSOs were the "shot in the arm" I needed to go on calling, even as the band conditions appeared to further deteriorate. Tuning around, I only heard a couple of signals on the band now; besides, it was nearly sundown. But you know how it is...just a couple more calls….

And suddenly, big as life, I hear FG8AR calling me! I quickly send off a 599 report, feeling my pulse all the way to my sending wrist. FG8AR replies with a 539 report. He says his name is Olivier and asks, "PSE UR PWR?" I reply, and he responds, "GUD GUD WITH 40 MW."

It took me a moment to recover after we'd signed; I kept looking at the tiny CK5875 envelope while trying to visualize the geographical location of the island of Guadeloupe.

Most exciting of all is the thought of what will be possible with Solidarity when the conditions on 20m are actually good!

References:

Ref. 1: http://aa1tj.blogspot.com/2010/12/solidarity.html

Ref. 2: http://aa1tj.blogspot.com/2010_11_01_archive.html

Ref. 3: The German web site about the tube, http://www.jogis-roehrenbude.de/Russian/1SH24B.htm

Ref. 4 clever electron optics link, http://www.radiomuseum.org/forum/5842_417a_highest_gm.html

Ref. 5 extraordinary emission efficiency link, http://www.radiomuseum.org/forum/russian_subminiature_tubes.html#11

Ref. 6: Soviet tube manual, http://www.oldradioclub.ru/radio_book/book/berg/berg.html

Ref. 7: To download this magazine issue, go to the BlogSpot page in Ref 1, find the corresponding text and click on the link there. It's a bit too complex to type in manually.

Ref. 8: MIG25 FOXBAT, http://en.wikipedia.org/wiki/Mikoyan-Gurevich_MiG-25

Ref 9: Use by Warsaw pact link click here, http://www.radiomuseum.org/r/voronezh_e_r_352_r35p_35.html

Ref. 10: former cold war adversaries, http://www.youtube.com/watch?v=XBOQdkIu6fM&feature=related

—de AA1TJ

Mounting BNCs on PCB Stock

I have a variety of circuits scattered around the house built "ugly" style on unetched PCB stock, and most of them use BNC connectors. I prefer the single hole mount type since they are a lot easier to use than the ones that require 4 screws.

Although one or two items have the BNCs mounted in holes drilled in the board (Figure 17, bottom), I much prefer having them mounted parallel to the board so the cables will be in line with it instead of at right angles (Figure 17, top). It also allows the board to be flat on the bench, allowing easy access to components. Scrounging up or making brackets doesn't appeal to me, and you have to mess with screws to mount those as well as worry about possible grounding issues.

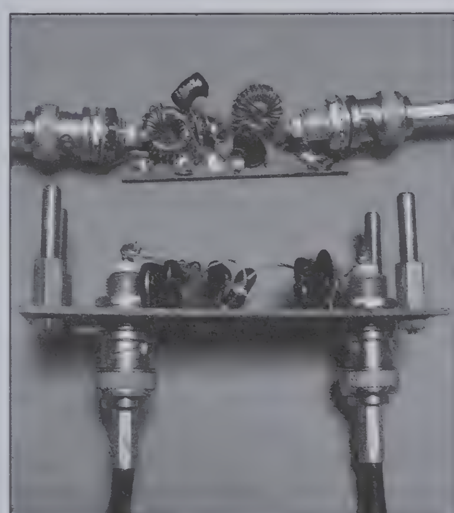


Figure 17—Mounting BNCs parallel to the board (top) is a bit more work but can make the assembly easier to use.

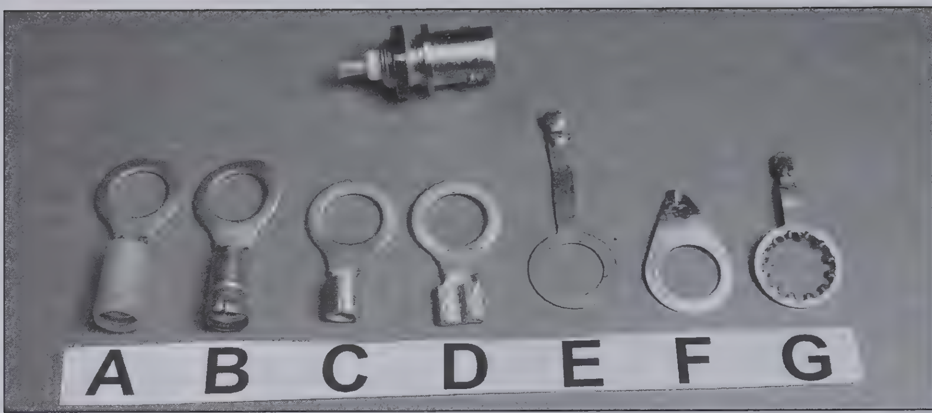


Figure 18—Ring terminals (ABCD) or ground lugs (EFG) can be used to mount BNC connectors to PCB stock.

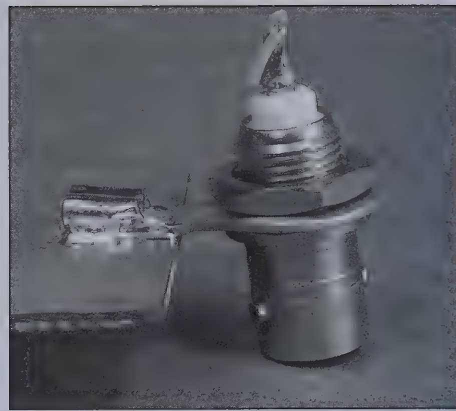


Figure 19—Mount BNC and tighten the nut after soldering, but before bending.

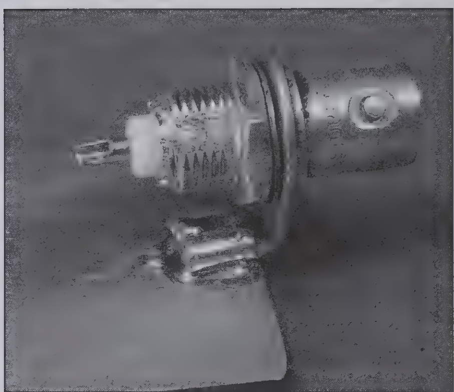


Figure 20—After the nut is tightened, bend the terminal up.

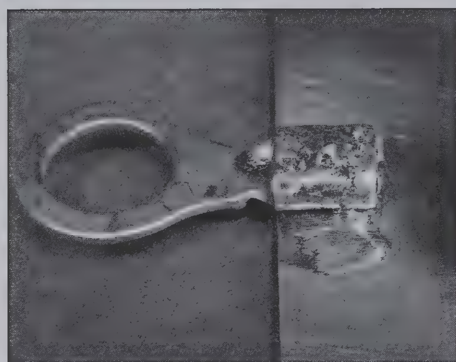


Figure 21—If the joint looks like this, add solder. All sides should have a good fillet for maximum strength.

Figure 22—If you would like a little extra strength, add a loop or two of wire and solder it to the terminal.

My favorite mounting style is using lugs or terminals of some sort. They can be soldered directly to the board, provide good grounding, and are reasonably strong mechanically, at least for moderately light use. The single hole BNCs I strip from old equipment frequently have ground lugs with them (like E, F and G in Figure 18) but they are usually fairly flimsy and don't provide a great deal of strength. They are OK for very light usage, especially if you hold onto the BNC while mating a cable to it, but they bend too easily. Also, the tabs are narrow and present a rather small footprint for soldering, which is where the mechanical support comes from.

I stumbled across a better option a few years ago, which are crimp style ring terminals intended for a 3/8" stud (Figure 18A), which is the diameter of a single hole mount BNC socket. The ones I picked up at a hamfest are the insulated type. The insulation has to be cut off as does the thin metal sleeve between the insulation and the crimp area. Not all types of insulated terminals have the sleeve (Figure 18B). According to the Tyco web page it provides support for the wire after crimping. The terminal now looks like Figure 18C. Flatten the round crimp end in a vise (Figure 18D) and solder onto the board. If yours has the sleeve, be sure to remove it; you want to solder directly to the lug itself.

After soldering down, insert the BNC ocnnector and tighten the nut (Figure 19); then the terminal can be bent up 90 degrees into final position (Figure 20). Don't bend the lug first and then install the BNC since there might not be enough clearance left for the nut, depending on where you have made the bend.

A lot of solder and heat should be used to give a good mechanical connection to the board. It's best to thoroughly tin the lug before putting it on the board, to reduce the amount of heat stress which could weaken the bond between the copper and fiberglass. Use plenty of heat and solder, and tin it around the entire periphery. It's also a good idea to tin the copper on the board ahead of time, again to reduce the amount of time heat is applied.

Be sure you have a good and complete solder fillet on both sides of the lug. Figure 21 shows what you don't want to see, since it has questionable wetting and could use more solder. Although it has a better (but not great) fillet on the far side and is soldered on the underside, giving good electrical connectivity, it doesn't have as much mechanical strength as it could. A general rule of thumb in electronics is that solder should not be relied on to provide mechanical support but that does not apply here, so insuring a good fillet on all sides is important.

(Before anyone says anything, yes, the one shown in Figure 20 really should have some solder added to it.)

Although I usually don't do this, you can also reinforce things a bit if you want extra strength and don't want to rely on just the solder. Drill some holes in the board next to the terminal, run a loop of wire over it and solder it to the lug, as

shown in Figure 22. (Although stranded wire was used here, solid is also acceptable.) You can twist or tie the ends of the wires on the other side, but I just bent them over onto the board and soldered them in place.

If possible, you should get uninsulated terminals. They are a bit cheaper, and you don't have to deal with the extra work of removing the insulation and sleeve; you start out at Figure 18C. If you have a choice, get ones which are intended for 10 to 12 gauge wire; they will be thicker and heavier than those for smaller wires, as well as having a larger diameter at the crimp area. The latter translates into a wider footprint for soldering and greater strength.

(According to the Tyco/Amp data sheets for terminals that accept the 3/8" stud, the ones for 22-16 gauge and 16-14 gauge are both 0.031" thick, while the one for 12-10 gauge is 0.039". Diameters at the crimp end are 0.136" and 0.160" for the first two, and 0.221" for the 12-10 gauge version.)

In addition to looking for these online and at hamfests, you can also try DigiKey or McMaster-Carr. The latter is a well known industrial supply house with all sorts of goodies and a very thick paper catalog. The URL is www.mcmaster.com and their online catalog is very easy to use and search.

DigiKey has the uninsulated Tyco Electronics #30972, catalog #A28309-ND. It's a bit over 28 cents each, with a minimum order of 10 pieces. McMaster carries a lug with the same specs (10-12 gauge wire, 3/8" stud, uninsulated), their catalog # 7113K375. A pack of 10 is $2.20.

In case you were wondering if the ground lugs intended for BNCs would be cheaper, they probably aren't. The only one I could find in a catalog is Figure 18G. Not only are they flimsier and with a narrower tab, they cost 42 cents each if you order at least 10 (carried by Mouser, an Amphenol RF item).

—de WA8MCQ

No Standard Pinout for the MRF237 (HW-9 Final)

If you've ever built an HW-9 you may remember that the MRF237 output transistors have a "reversed" pinout, which is clearly indicated in the manual. It's the usual triangular arrangement, but instead of the standard emitter-base-collector

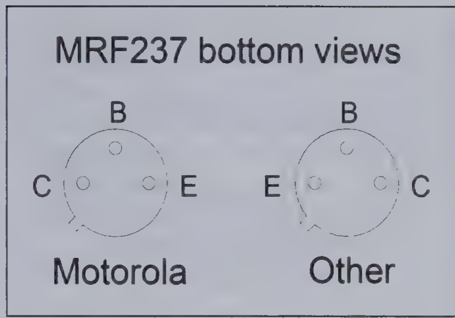


Figure 23—The sequence of pins on MRF237 transistors depends on who made them.

(EBC) sequence it is collector-base-emitter (CBE). This isn't usually a problem until someone tries replacing them with a different transistor, with the "normal" EBC sequence, and all that's needed is to move the leads around a bit. If replacing bad MRF237s with new ones, they simply drop in place.

Well, no, not necessarily. Unfortunately it turns out you can't do that all the time, even though the part number is the same; you may still have to shuffle the leads because not all MRF237s are created equal. Ian Liston-Smith, G4JQT, pointed out in a post to the newly created HW-9 Users Group forum on yahoo.com that not all MRF237s have the same pinout. Some have the traditional EBC pin arrangement, and it's not a case of some counterfeiter making bogus transistors and getting it wrong. They are made that way and documented in the manufacturer data sheets.

The original MRF237 by Motorola, with the reversed CBE pinout, is used in the HW-9 but they discontinued the part long ago. At least one other manufacturer has picked it up, and they make it with the "standard" EBC arrangement. (See Figure 23.) The bottom line is that if you ever replace the output transistors in the HW-9 (or build something from scratch with the MRF237) you have to verify the lead order even though it's the correct part number. If a Motorola part, just drop it in. If made by another manufacturer, you will probably have to swap the leads around.

W7ZOI Inductor Calculator Includes Tiny Air Wound Coils

Wes Hayward, W7ZOI, recently added a coil calculator program to his web site. There are numerous toroid calculators available but this one is worth a look for a couple of reasons even if you already have one. Select any of the 29 cores listed, click on "Calculate L of toroid" and it spits out a listing giving inductance (in both nanohenries and microhenries) and length of wire for 1 to 50 turns. Having that in a single list is very handy.

You can specify more than 50 turns if

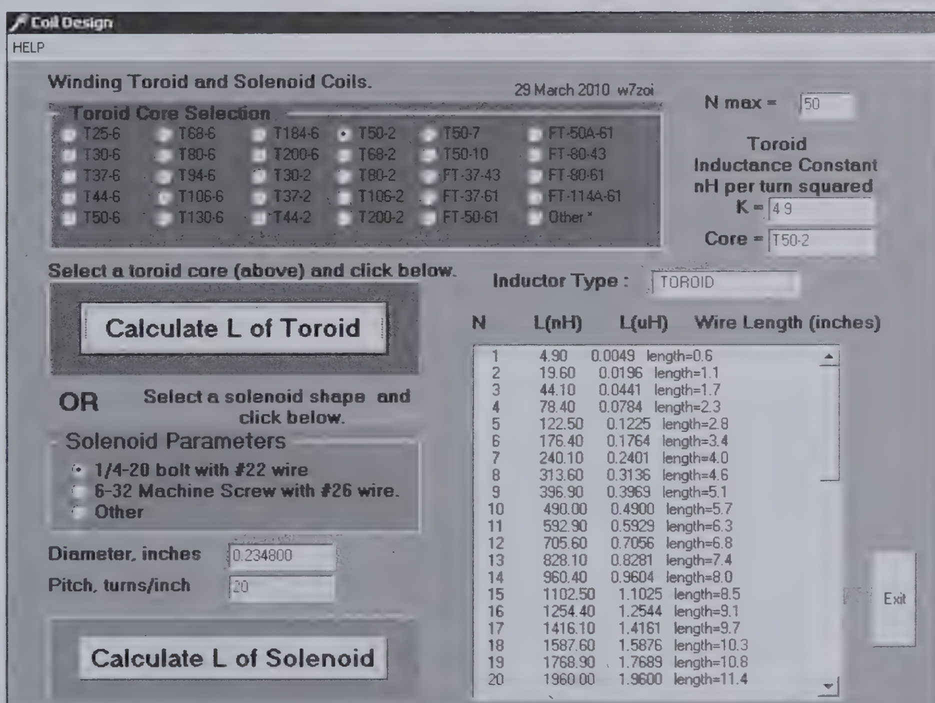


Figure 24—Screen shot of the W7ZOI inductor calculator; the values for a T50-2 toroid are shown.

you wish. You can also get the info for any core not listed by selecting Other and entering a number in the K block. That's the "Toroid Inductance Constant", in "nH per turn squared". (More on that later.)

Figure 24 shows a screen capture of the program, with calculations for a T50-2 toroid. (Please note that the wire length is only for the coil itself and no pigtails; add a couple of inches for leads.)

As they say on TV, "but wait, there's more!" There is another function that makes this calculator really useful for the hardcore homebrewer. It has a section that does calculations for tiny air wound solenoid coils. If you read *QEX* you've probably seen occasional articles that have coils that are wound on a screw, which makes a handy and repeatable coil form. (The screw is removed before use; it's just for winding.) While toroids are usually the coil of choice for the HF range, once you start getting above 30 MHz air wound inductors become more attractive. You can select a 1/4-20 bolt or 6-32 machine screw, or specify any other size you wish.

To download the coil calculator, go to http://w7zoi.net, click on "Experiments" and then on "Coil Design Program (download)".

As for the K factor, it is related to the A_L value, or it is the A_L value, depending on what manufacturers info you go by. At one time, many years ago, pretty much the only powdered iron cores that homebrewers used were sold by Amidon but manufactured by Micrometals. Amidon listed an A_L value in their literature for all cores, along with a few formulas to use it, and it was microhenries per 100 turns. Presumably that's how Micrometals also specified it at the time.

Amidon still sells a variety of products, including powdered iron cores, although they no longer carry the Micrometals line. They still use "microhenries per 100 turns." Micrometals is still very much in the business of making powdered iron cores, but their catalog and web site now specify A_L as nanohenries per turn squared, which is a much smaller number. This is the K factor used in the program, and is 1/10 of the numbers used by Amidon.

If you are doing your own calculations you can use either manufacturers A_L numbers as long as you use them with the formulas supplied by the same manufacturer. The results are the same either way; just don't mix and match the A_L numbers and formulas. However, for this program you must use the Micrometals "nH per turn squared" A_L numbers or the results will be off by an order of magnitude.

You can download the "nH per turn squared" values from the Micrometals web site. Go to http://www.micrometals.com/parts_index.html and look under the RF Toroids area. The cores are split up into 5 sections according to diameter. (While you're there, you can also download a PDF copy of their RF cores catalog, which has lots of good information. At the home page, click on Catalog Request. The top of the next screen allows PDF downloads of various things; get the RF Catalog, which is currently edition H.)

—de WA8MCQ

The Fine Print

You know the drill—send your info to Severn any way you can get it here (e-mail, snail mail, floppy, CD, handwritten on a napkin, etc), or tell me where you found something of interest on the Internet. We take care of the rest, editing, redrawing, etc. The readers are waiting!

Corrections and Comments

In the Fall 2010 issue of the *QRP Quarterly*, we were fortunate enough to have another article from Dave Gordon-Smith G3UUR. Unfortunately, the title of the article was published incorrectly. The title should have appeared as "Notes on Measuring Quartz Crystal Motional Parameters" in both the article heading and the table of contents. As published, the title was not only grammatically incorrect, but also technically incorrect. Our sincere apologies to our readers, and the author.

Also, we recieved an article on designing Class E amplifiers from Ward Harriman AE6TY. It was our intention to run it in this issue but due to space constraints we will run it in the Spring 2011 issue.

—Editor, Brian Murrey KB9BVN

FDIM Preview!

Norm Schklar—WA4ZXV fdim@qrparci.org

FDIM - Four Days in May
May 19-22, 2011

The Premier North American QRP event this year! Get it on your calendar now! Thursday-Sunday, May 19-22.

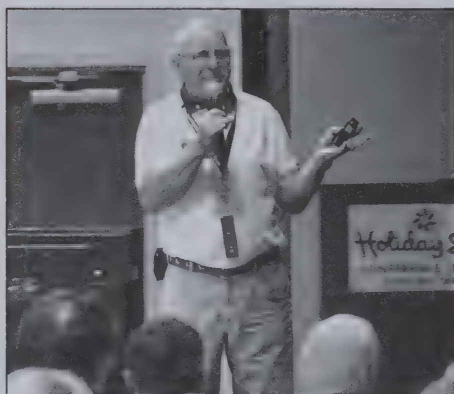
What a great FDIM we have planned for this year. If it's your first or 16th, there will be something here for you. QRP-ARCI is sensitive to the first time attendee and will try to make your first FDIM as fun and interesting as possible. We will also have spouse/guest activities.

Registration and getting acquainted begins on Wednesday evening. Seminars are most of the day Thursday, with "meet the speakers" and an open room for some casual show and tell, vendor displays and plenty of time to swap tales. Most of Friday daytime is open to attend the Hamvention® and visit the QRP-ARCI Toy Store. We'll have plenty of room at the hotel during the day for casual meetings

and time to visit with old friends and make new ones. This year we hope to open the Banquet area for Vendors and some other learning experiences. Friday evening activities usually include "show and tell", vendor displays and a judged home brew contest. Most of Saturday is again open for

FDIM 2011
Celebrating
50 years of
QRP-ARCI

the Hamvention, and we have a great social event, our annual banquet and awards presentation. There will be plenty of door prizes that evening. Sunday is the Hamvention and check-out.



Most of the speakers for the seminar have been contacted and confirmed. We'll have a "meet the speakers" social gathering after the seminar, where you'll have an opportunity to meet, question and discuss QRP with the speakers.

Don't miss out on the show and tell. You'll have an opportunity to bring out your QRP related projects and put them on display. Your contemporaries will have a chance to roam through the displays and see the excellent craftsmanship used in these special exhibits.

We'll have a judged project contest and it shouldn't surprise you to find a fun contest or two during the weekend. We've had QLF, split paddle, and other fun activities in the past.

QRP related Vendors are invited to exhibit both Thursday and Friday evenings. We're sure you'll find many special FDIM discounts.

The hotel is including breakfast with the price of the room. The hotel has been very accommodating and a pleasure to work with. You'll find fast food restaurants across the street from the hotel. Dress is casual for all events.

We will again be at the Holiday Inn, Fairborn, OH. Reservations and special room rates for FDIM are available through www.FDIM.QRPARCI.org. Remember, all discounted hotel rooms are released

only through QRP-ARCI. Instructions will be posted as soon as the hotel is ready to start processing our Room Block.

This is preliminary information. A complete schedule and list of activities will be posted on the web site as we move through the process.

Questions or comments:

Norm Schklar, WA4ZXV
FDIM2011 Chair
fdim@qrparci.org
ph 770-313-9410

(Last updated January 11, 2011)

FDIM 2011—Homebrew Contest and Show & Tell

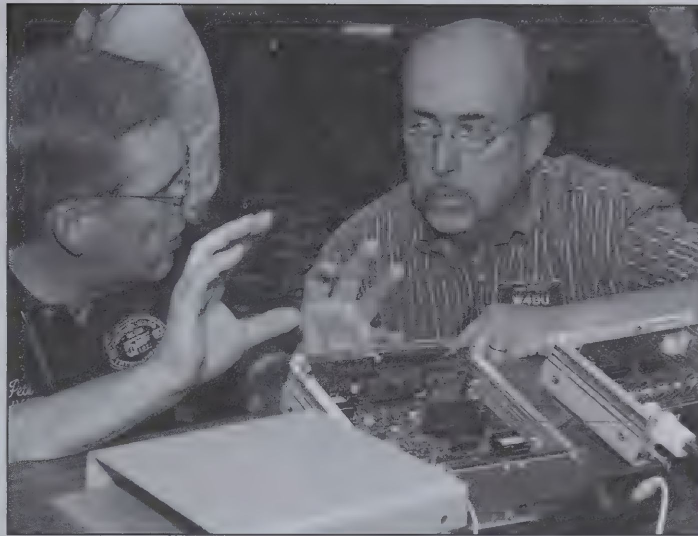
As in the past, we intend to allow entries in the Homebrew Contest* to be displayed in the Ballroom on Thursday night, May 19; and Friday night, May 20, between 8 p.m. and 10 p.m. To enter an item in the contest and insure that it is part of the voting (on Friday night), you must register your item on either Thursday or Friday night between 7 p.m. and 8 p.m. A registration table will be outside the main Ballroom at that time on both nights.

Each entry will be given a card that lists the category and item number, along with a description of the item and the call sign of the owner. This card must be displayed with your entry.

Judging will be done between 8 p.m. and 10 p.m. on Friday night, so although you can display your item on both Thursday and Friday nights, your entry must be displayed Friday night to insure it is part of the voting. The judges will be the attendees of the Vendor night on Friday. Each will be given a ballot that must be submitted by 10:00 p.m. on Friday. There will be six categories. They include:

1. All Homebrew (Xcvr, Xmtr, Rcvr)
2. Modified Kit (Xcvr, Xmtr, Rcvr)
3. Station accessories (homebrew or modified kit)
4. Test Equipment (homebrew or modified kit)
5. Antennas
6. Special Category
7. Best of show

Winners will be announced at the awards banquet on Saturday, May 21. If you are bringing an item for the Show & Tell* and do



not wish it to be judged, you need not register, simply come to the ballroom between 7 p.m. and 8 p.m. and set it up on a table that we will assign to you. Whether you are part of the Homebrew Contest or the Show & Tell, please let us know your intentions when you register so that we can assure we have adequate space for all.

***Definitions:**

Homebrew Contest—You bring one of your latest projects and display it. On Friday night, attendees will be able to vote for a winner in one of the categories.

Show & Tell—You bring one of your latest projects and display it. Your project will not be part of the voting in the Homebrew Contest.

2011 FDIM Information Summary

Dates:	Thursday, May 19 through Sunday, May 22
Location:	Holiday Inn Fairborn, Fairborn, OH (Dayton area)
Registration:	Online—www.fdim.qrparci.org
Hotel:	Through QRP ARCI only—info at www.fdim.qrparci.org
Seminar:	Thursday, May 19, 8 a.m. – 4 p.m.
Activities:	Buildathon Homebrew Contest Show & Tell Vendor Night Meet the Speakers Guest/Spouse Program Awards Banquet (with many door prizes) And of course, the Dayton Hamvention®

SDR Cube Transceiver

George Heron—N2APB
Juha Niinikoski—OH2NLT

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juha.niinikoski@sitecno.fi

The SDR Cube (Photo 1) is a portable Software Defined Radio without a PC! Couple this design with your favorite Softrock to take advantage of SDR capabilities on the bench and in the field.

As hams, I think we inherently have a visceral affinity to knobs, meters, switches, pots and other standard front panel controls that have been built into our radios over the years. Sure we are technologists too, and many readers of *QRP Quarterly* are pushing toward newer radio designs that incorporate microcontrollers and computer interfaces. But at the end of the day, many ops feel that it just does not "feel right" when controlling a transceiver with a PC screen and a mouse, whether it is late at night during a contest or while ragchewing with friends in a regular sked.

Yet "software defined radios" up to this point have depended on—in fact required—a PC of some sort for A/D conversion by the sound card, the CPU's processing power in order to modulation and demodulate in digital land, and a big display screen to serve as a colorful front panel with virtual dials and meters. Yes, laptops are becoming smaller, less expensive and more powerful by the month, but many hams still would not feel comfortable throwing even a netbook into a backpack for a field outing with their radios. And still there is that darned mouse/pointing device used to control volume!

So this need to capture the advanced capabilities of software defined radio, coupled with the need to keep it looking and feeling "like a radio", formed the starting point for our project: the SDR Cube Transceiver. We wanted to benefit from the flexibility that SDR offers with its innate ability to handle virtually any operating mode—SSB, AM, CW, and digitalñwith just a new software file or program loaded into the radio. Yet we still wanted conventional knobs for controls and compact packaging. In a recent posting on the SDR-Cube email list, one fellow very presciently stated: "We don't drive software defined cars or operate software defined microwave ovens. We use cars and ovens. So why must we have software and computers so much in our face when dealing with SDR in our hobby?" We agree completely!

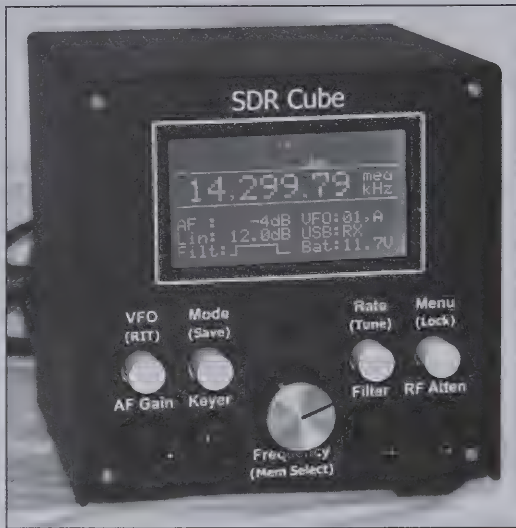


Photo 1—The SDR Cube Transceiver. Housed in a 4 x 4 x 4 inch black powder-coated aluminum enclosure, this self-contained Software Defined Radio couples with a Softrock RF front end to perform as a full-featured SSB and CW transceiver for the HF bands—without the need for a PC! The Cube design contains a full user interface, DSP processing, I/O connectors on the rear panel, and 27 in3 shielded space internally for a Softrock. The Cube ideally interfaces to the NUE-PSK modem for digital mode support, and future growth will directly encompass digital modem functions and more.

Our intention with this article is not to provide yet another detailed tutorial on the design methodology and DSP coding techniques used to create the SDR Cube. The recent article series in these pages by Ward Harriman, AE6TY did an excellent job at that and can serve as a good reference for those wishing to learn embedded programming or strike out in their own directions. We will instead review the fundamental components that make up the Cube and explain the challenges at each of the design stages and the reasoning for our choices.

In the end, we hope that readers will better understand the task of constructing such an embedded DSP controller, and coupling it with a quadrature sampling RF front end like any of the popular Softrocks so they might attempt to replicate the design. We provide numerous paths that others can follow to easily hop onto the SDR bandwagon and end up with a very cool transceiver that is unlike anything else around. And most importantly, this SDR will have a conventional look and feel with knobs, switches and compact packaging. After all, our informal tag line for the SDR Cube is… "We don't need no stinkin' PC!"

Background

The genesis of this type of embedded DSP approach to a software defined radio has its root in Finland, at the shack of OH2NLT (co-author of this paper). Over the course of four years, Juha Niinikoski had been experimenting with the basic building blocks in order to show how a "cheap DSP" solution could be used to create a ham radio. In fact, using that very name for his early design with the Microchip dsPIC processor, Juha was able to demonstrate a minimalist working radio based on a dsPIC30F processor to control the phasing of two quadrature-related sampled data streams.

The CheapDSP results were very encouraging and early in 2009, N2APB (the other author of this paper) learned of Juha's work and it became something to be studied and replicated. George had always been focused on providing portable radio solutions, as evidenced by his recent co-design of the NUE-PSK Digital Modem which also used a dsPIC processor.

We began collaborating on an evolved and more complete SDR implementation, this time using the more capable dsPIC33F processor at the heart of the design. Using this Microchip controller we would have greater processing power, more input/output pins for an integrated and capable user interface, and we could inherit some of the features and drivers that made the NUE-PSK modem so popular—namely, the spectrum display and FFT processing, and the drivers for the rotary encoder, and the

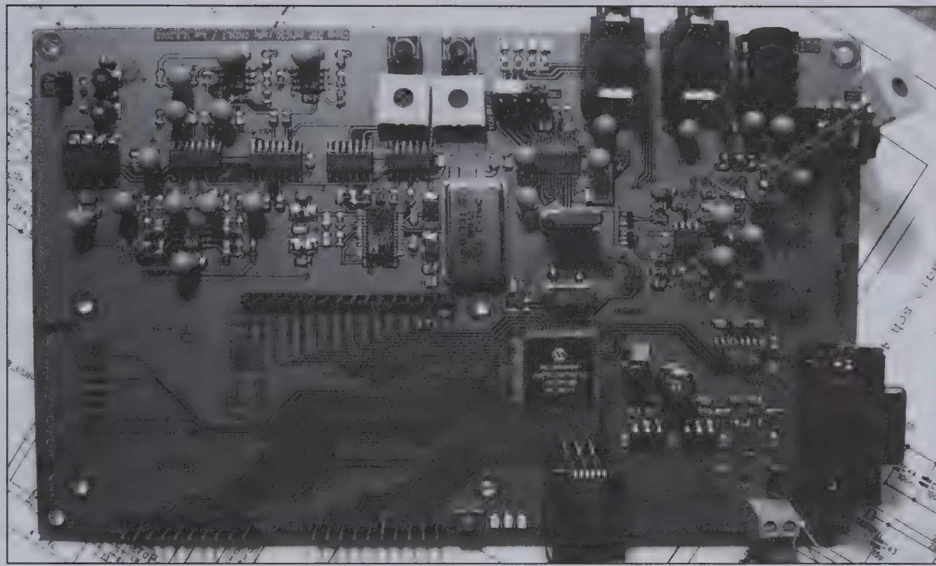


Photo 2—First prototype; single board SDR controller with integrated transceiver.

field programming capability.

Together we embarked on a vastly enhanced design path, working "transoceanic" and across many time zones to ultimately create the encompassing SDR Cube Transceiver.

SDR Cube Overview

The SDR Cube is a QRP transceiver consisting of an embedded DSP controller coupled with a Softrock as the RF deck. A PC is not needed with this SDR because all the signal processing is accomplished ""in the box". Sized at 4 x 4 x 4 inches, the Cube contains a full complement of built-in user interface: graphic LCD for spectrum display, typical controls for frequency, mode and signal management, and I/O connectors for connection to the outside world. The Cube design is optimized to internally accommodate the popular Softrock RXTX 6.3 electronics. Alternatively, a connector on the rear panel allows the SDR Cube to connect with virtually any other quadrature sampling RF front end that uses the standard I/Q baseband audio signals. Different from other experimenter single board solutions, the Cube was designed from the start to serve as a complete and standalone transceiver - the power and flexibility that software defined radio brings, with the convenience of a full user interface with standard (physical) radio controls that most operators prefer, and the small size to allow easy portability.

The SDR Cube controller consists of three interconnecting p.c. boards that serve to interface with the user and provide the signal processing necessary for processing the in-phase and quadrature (I and Q) audio signals to/from the RF front end. The I/O board provides for the connection of the usual radio peripherals—mic, paddle headphones—and an RS-232 port for enabling the Cube's software to be easily updated by the user when needed.

Digital mode support—While the initial release of the SDR Cube software provides support for SSB and CW modes, it relies on the use of an external modem for support of the digital modes. One can use an application on a PC connected to the audio output of the SDR Cube Transceiver, much as it would connect to any other SSB-capable rig. However, consistent with the design goals of portability and PC-less operation, we also provided a special, optimized interface for connection to the NUE-PSK Digital Modem for the processing of digital mode communications. Further, while the initial release of the Cube software handles this interface to the modem in a standard way with analog audio signals, the next version will bypass the redundant conversion to/from analog audio and pass digital audio between the Cube and NUE-PSK modem. This optimized interface offers improved SNR benefits that are already seen on the bench prototypes. In follow-on versions of the SDR Cube software we will integrate the actual modem source code in order to natively support the digital modes in the SDR Cube without the need for any external digital modem.

The Softrock "RF front end"—The SDR Cube is designed to interface to any quadrature-based RF front end that provides I/Q baseband audio signals. We use the terms "RF front end" and "RF deck" to mean the electronics that perform the mixing, amplification and filtering of RF signals for an HF radio. The most popular and prolific RF deck around is the Softrock family of small and inexpensive kits. Some 11,000 of these boards in different flavors have been sold around the world already, and each depends on a PC for signal processing and user interface. So by designing the SDR Cube to easily interface with this huge installed base of Softrocks,

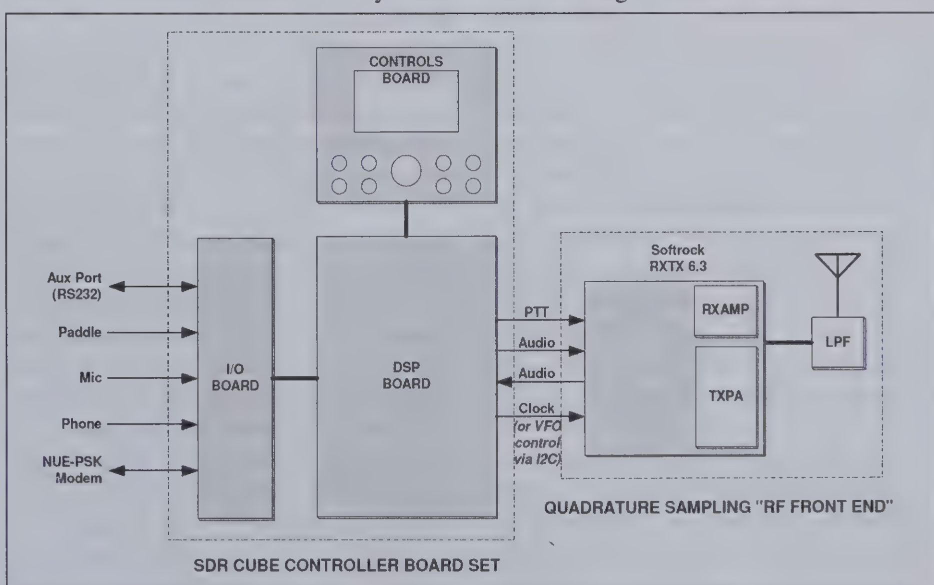


Figure 1—Block diagram of the SDR Cube transceiver.

The Evolution of Software Defined Radios

Software Defined Radio (SDR) in the Amateur Radio community has been making great strides in recent years. From the innovative and ground-breaking products of Gerald Youngblood, KSDR of Flex Radio some four years ago, to the most recent state-of-the-art designs in the HPSDR group, SDR technology has really now come of age. This current state-of-the-art has also been greatly enabled by the tireless work of Tony Parks, KB9YIG, the father of the Softrock designs, who has empowered thousands of hams worldwide with his series of inexpensive radios that work with PC sound cards.

Each of these radios in their most basic form consists of electronics that sample the incoming RF after it has been converted down to baseband and send the results to a PC for digital conversion. he PC then performs the complex demodulation computations so we operators can understand the SSB, AM or digital mode communications coming in. And of course the reverse happens for transmit, whereby the PC presents electronic signals to the front end electronics for mixing and ultimate transmission.

However throughout all the excitement of PC-based software defined radio, there has also been a quieter background quest for a form of SDR that is not tethered to a PC. While the PC offers seemingly unlimited processing power, gorgeous user interfaces and lots of memory, the PC is still an expensive and cumbersome accessory to take to the field when the need arises for portable operations. Classic problems are encountered with regard to the ability to see the PC display in bright sunlight, and powering the PC and the power-hungry SDR front-end electronics is tough with limited-capacity batteries. In general, lugging around an expensive and delicate laptop is not something one wants to regularly do. Also, many hams just do not care to operate a ham radio with a mouse controlling knobs shown on a on a PC screen.

Most would still agree that the performance of such a PC-based radio is of great value, given the flexibility offered with SDR's innate ability to handle virtually any operating mode with just a new software file or program loaded into the radio.

Numerous experimenters have been seeking to develop an integrated SDR transceiver to address the shortcomings of using a PC in the field, while retaining enough of the benefits of SDR in general so as to have an inexpensive-yet-powerful transceiver. Embedded SDR projects are in progress with in the High Performance SDR Group (HPSDR) and yet another is being described in an excellent article series by AE6TY in *QRP Quarterly* magazine. Many of us experimenters are standing on the shoulders of previous pioneers in the field of DSP for Amateur Radio: Rob Frohne KL7NA, Lyle Johnson KK7P, Rick Campbell KK7B and others. The handbooks from the ARRL and RSGB, as well as the seminal work of *Experimental Methods for RF Design* by Hayward/Campbell/Larkin, are replete with the basic building blocks that we designers of today are employing in our SDR implementations. *—N2APB*

we provide a way for every Softrock owner to decouple from the complexities of using the PC as a radio, while simultaneously tapping into a ready-made market without needing first to design the RF deck ourselves. A slight downside of this approach is that the simplified designs of the Softrock naturally offer some design compromises that result in lower RF performance—sensitivity, clock feed-thru, unwanted mixing byproducts, etc.—which may in turn be perceived as SDR Cube limitations. However there are other higher-ended I/Q-based products that also work in a stellar fashion with the Cube; products such as the Genesis Radio SDR family, the original FlexRadio SDR-1000 electronics and the FA-SDR from Funk Amateur magazine. And who knows, in the future perhaps someone will design a high-performance RF deck to mate specifically within the SDR Cube enclosure!

Features, Goals and Specifications

Good designs normally start with a description of the intended goals, and how well the designers keep those goals in sight usually determines the degree of success that can be achieved for the intended market. In our case, it was important for us to keep in mind the natural constraints that come from limited resources and computing power of an embedded signal processing system. Our overriding goal was to provide "just enough" features without over-taxing the available resources; or conversely without creating a radio with more bells and whistles than are actually warranted.

Portable, standalone, QRP-level, SDR transceiver—We wanted to provide an SDR transceiver for voice and CW modes that did not require a PC for signal processing or user interface.

Built-in "RF deck"—While designing an embedded signal processing engine is difficult and time consuming, it would take even more time to also develop unique RF electronics to handle the front end of the HF transceiver. So by designing around the most popular Softrock of all time, the RXTX v6.3, we were able to tap into thousands of users who already have this RF deck, thus enabling them to keep costs down when building the SDR Cube.

HF modem: processor and codec—We decided to use the somewhat dated Microchip dsPIC33F processor, despite there being faster DSP chips around these days. There is a lot to be said for a designer being comfortable in a known development environment such as this, and another project using the dsPIC33F (the NUE-PSK Digital Modem) offered some helpful functions and drivers that we could inherit in the SDR Cube. And for similar reasons, the older TLV320AIC23B codec is still plentiful and cheap, and it served us well for a first implementation. Both of these all-important components can be upgraded in future hardware/software versions of the Cube if needed and warranted.

Physical user interface (display and controls)—We were very interested in having this SDR project not look at all like a computer, much less have to depend on the PC for anything along the way. Given the smaller form factor we wanted for portability, we determined the bare minimum number and type of controls that would look like a "real radio", while at the same time still have it be a pleasure to use. So often in these days of microcontroller-based rigs and station accessories, multifunction pushbuttons and menus-within-menus displayed on an LCD make the radio confusing and difficult to control.

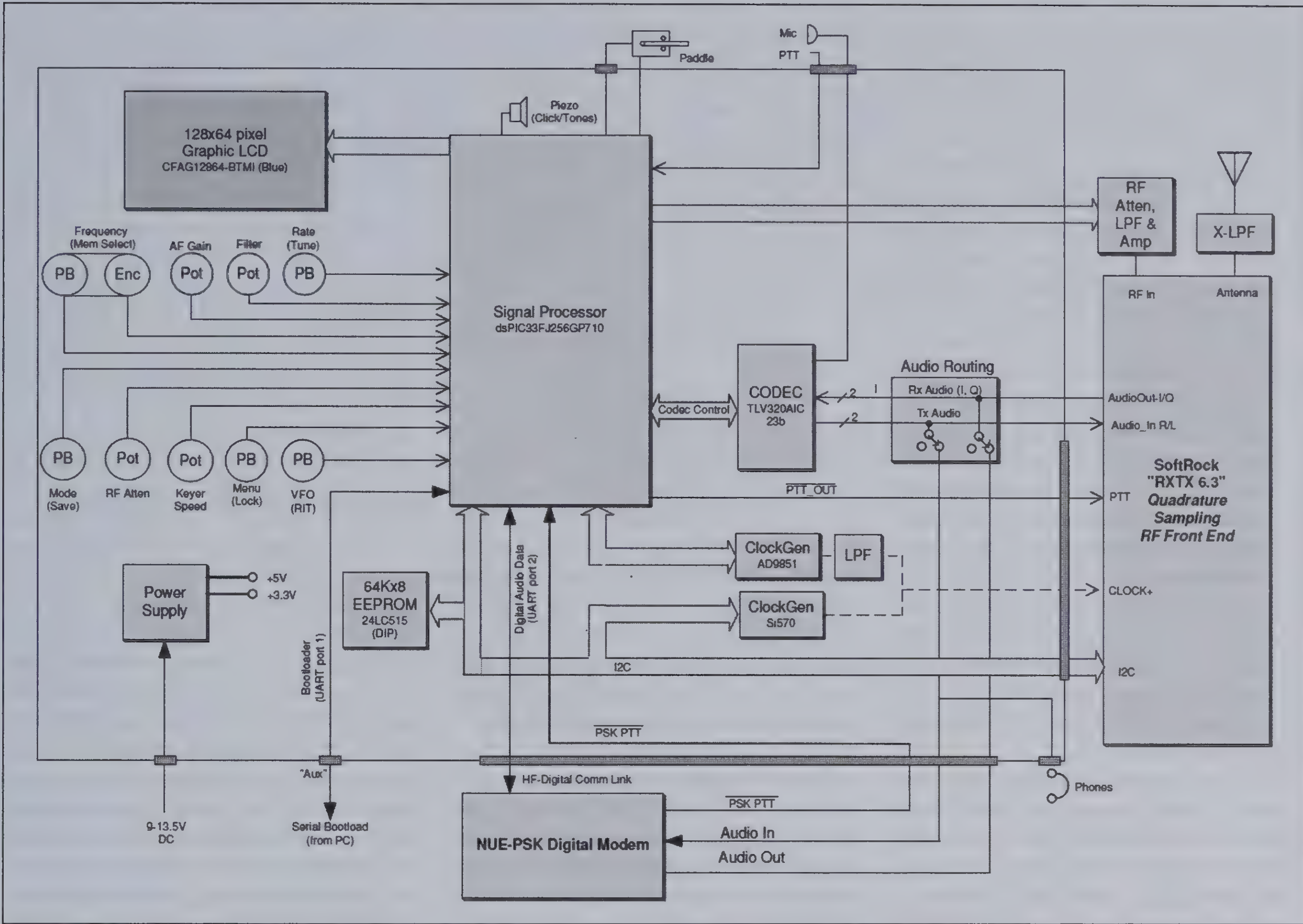


Figure 2—SDR Cube hardware architecture. Illustrates designed-in controls, graphic display, and tight integration with NUE-PSK Digital Modem

While we do have four pushbuttons as modal controls menu, VFO, Tuning Rate and Mode), we limited the number of functions that were available with each pushbutton and made the state of the radio quite visible in the large graphical display at all times. Four standard mini-potentiometers were used for the often-changed functions: audio level, RF attenuation, keyer speed and audio filter. And for the most often used control on any radio, the frequency tuning dial, we took pains to ensure that we used a smooth-turning and good quality rotary encoder, topped off with a fairly nice aluminum knob. A small piezo speaker sits behind a hole in the front panel serving as an optional "click" for user functions and for an audio sidetone that can double as a code practice oscillator! Lastly, the most exciting part of the User Interface was the bright blue graphical LCD. At 128 x 64 pixels, it offers enough resolution to allow us to simultaneously display many different status indicators (audio and RF levels, keyer speed, operating mode, frequency memory bank in use, RIT/XIT, Rx-Tx) along with our biggest feature of the front panel: a bandscope displaying 8 kHz of live spectrum that the Cube is tuned to.

Software field upgradeability—A feature that has served both of us well in our previous designs (Micro908, NUE-PSK, Juma TRX) is the ability for the SDR Cube software to be updated by the customer whenever newer versions become available. This integrated bootloader enables the user always be up-to-date after flash programming the latest binaries via the RS-232 serial port available on the rear panel's Aux jack.

Hardware Discussion

Diving just a little deeper into the hardware architecture of the SDR Cube, Figure 2 illustrates how the dsPIC33F is at the heart of the design. This powerful embedded processor handles the many front panel input controls, displays text and graphics to a 128 x 64 pixel graphic LCD, and controls the audio data paths through the codec and over to the Softrock RF deck on the right. And of course the dsPIC performs the phase shifting of the I/Q digital signal streams as part of the HF modulation and demodulation operation.

The dsPIC33F is a 40 MIPS controller (40 million instructions per second), which is only moderately capable compared to today's technology. But unlike some of the more powerful embedded DSP controllers from Texas Instruments or Freescale, the dsPIC package is relatively straightforward`for homebrewers to attach on pc boards. Even with the 100-pin package of the dsPIC model we use is able to be

attached in any number of ways: flood solder and wick off, individually soldering of each lead, or using the KD5SSJ solder paste and heat gun solder reflow technique. Microchip offers a free, very capable and intuitive development environment called MPLAB, enabling experimenters to focus on the design and not the tool. For these reasons, the dsPIC controller remains popular in the experimenter community.

The dsPIC offers enough capabilities for designers to provide some demanding solutions: a 16-bit fixed point architecture, yielding 96 dB dynamic range in its computations. It has 40-bit accumulators and hardware support for division operations, barrel shifters, multipliers and a large array of 16-bit working registers—all of which provide ample DSP power for the operations performed in such an embedded SDR. Admittedly, the dsPIC controllers are getting "long in the tooth", however Microchip is committed to continuing the product line, perhaps due to continuing applications like these here in the ham radio community.

For the all-important A/D and D/A conversion block we used the Texas Instruments TLV320AIC23B high performance stereo codec. In our first implementation, an 8 kHz sample rate is used, as anything much more than this is difficult for the dsPIC to handle. A higher sampling rate has a two-fold performance cost: (1) Filtering must be performed more often and at the pace of the sample rate; and (2) More filter taps are needed, resulting in more computation time required, which is a subtle and often-overlooked consideration in design. In later versions of Cube software we may be implementing additional processing hardware to accommodate increased computational power; for example, providing a wider spectrum band scope and digital modem functionality. So keeping the computing overhead lower is just as important as achieving adequate quality. The integrated headphone amplifier, programmable gain microphone amplifier, and SPI control bus were important selection criteria for this codec.

Optimal gain distribution in the system has not yet been determined, and AGC is an important (and difficult) feature to implement. Thus we have started getting our hands around receive path gain by implementing a controllable RF Attenuator as a plug-in for the Softrock board in place of its existing BFP board. In this way we can have several levels of signal attenuation and gain to assist in establishing optimal signal levels throughout the system.

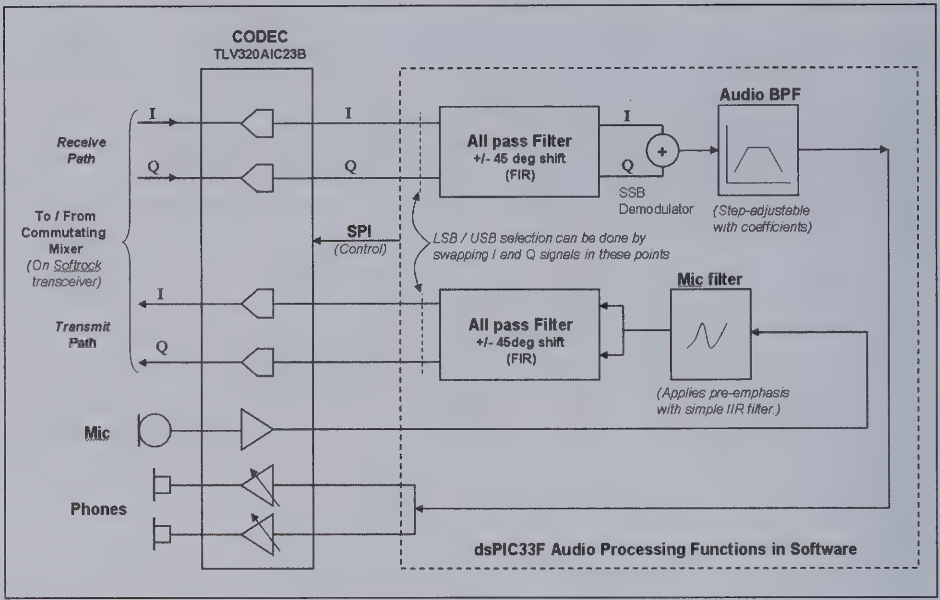


Figure 3—Software processing block diagram.

Clock generation is optimally provided by the dsPIC's I2C bus controlling the Si570 present on the Softrock board. For those RF decks that do not have a built-in clock generator, the SDR Cube design can provide the clock by its own Si570 clock chip or by a classical AD9851 DDS signal generator and low pass filter. Any of these three clocking methods may be implemented in the Cube.

Software Discussion

The design of the SDR Cube software is based on the classic "phasing method" of SSB generation and detection, whereby a 90-degree delay is imposed on the source audio signal coming from the microphone, or from a NUE-PSK Digital Modem. The resultant signals are applied to a pair of mixers—in our case these are provided on the Softrock board—with 0- and 90-degree LO signals. The output of the mixer is amplified on the Softrock and presented to the output BNC connector on the rear of the Cube.

The receive path works in a similar manner, but in reverse. The received signal is mixed with LO signals on the Softrock card that are at 0- and 90-degrees, producing the I and Q signals. These component signals are digitized by the Cube hardware and the dsPIC controller imposes a 90-degree phase shift between them by passing them through two balanced and matched FIR filters, one advancing the signal 45 degrees and the other delaying the signal by 45 degrees. Maintaining accurate phase delays and corresponding amplitudes has a direct impact on the quality of the demodulated signal. The demodulation occurs at the summing junction, shown in Figure 2 below; when the dsPIC performs the computations for the desired mode, the receive audio is able to be heard in the headphones.

Note that either USB or LSB may be demodulated merely by reversing the I and Q signals where indicated in Figure 2.

Recalling the computation for AM demodulation: AM = SQRT(I^2 + Q^2), even this mode is able to be accomplished.

Codec—The TLV320AIC23B is a relatively mature codec. The main reason we used this particular part was the accumulated SW experiences we have for controlling it. The '320 also provides handy adjustable input amplifiers, mic amplifier and head phone amplifiers. Most of the audio signal routing is done with the codec mux block and codec driver software. Only the audio path for the PSK modem needed external switching.

The TLV320AIC23B provides 24-bit ADC output. Our processing happens in 16-bit resolution but we can benefit from the 24 bits by selecting the magnitude that we use from it. For example, if we start from bit 22 instead of bit 23 we get 6 dB

gain, and so on. However the signal/noise ratio gets worse on every bit reduction, and practical numbers are 1 to 3 bits. More can be used, yielding 6 to 18 dB of "free" gain.

System Gain Distribution—And speaking of gain, we have plenty of adjustment opportunities throughout the system, from antenna to speaker. Each of the blocks shown in Figure 4 offers an opportunity to change the gain, and the goal would be to set each signal to the greatest level able to be processed by that stage without overflowing the digital registers, yielding the most dynamic range for each stage. Different from an analog radio, when digital registers overflow much more noticeable (bad) effects are evident. So it becomes most important to ensure that the digital levels are well managed.

And therein lies the challenge (opportunity) for providing automatic gain control (AGC). A designer's first tendency is to implement a simple algorithm such as "when the codec signals are too high, reduce the line gain", or even something a tad more complex such as a log filter based on envelope detection, with separate up/down slopes. However if the other gain blocks are not also properly handled, simple solutions fall apart in real world conditions. Further, the design needs to handle a number of conditions: in-band signals that pass through all filters, out-of-band signals that do not go through the DSP filters, and signals greater than the Nyquist rate that can overload the codec input. VK6APH wrote an excellent paper describing the AGC challenges, as did Sabin et al. (See our References section.) These papers are guiding us for implementing AGC in one of our next releases. At the end of the day, "no AGC" is better than having poorly-implemented AGC—and in the initial release of the SDR Cube software, the operator is provided with good manual control of the system gain via the RF Attenuator control on the front panel.

Basic system timing—Of course there is no operating system in our embedded SDR Cube design. If anything, there would normally be an embedded OS such as VXworks (or equiv). But here the processor is quite simple and the timing needs are somewhat extreme, so we are running on "bare metal" with a simple master loop performing the computations and I/O data movement as needed. DSP calculations are done on every sample at 1/8000 Hz, or 125 μs sample rate. The filter calculations for each sample takes about 16-to-20 μs. The bandscope FFT is calculated in main loop when the FFT data buffer is full at 16 ms intervals. The keyer and other time critical tasks operate as timed with a 1 ms interrupt. And the processor's PWM generator hardware is used to produce clean UI tones.

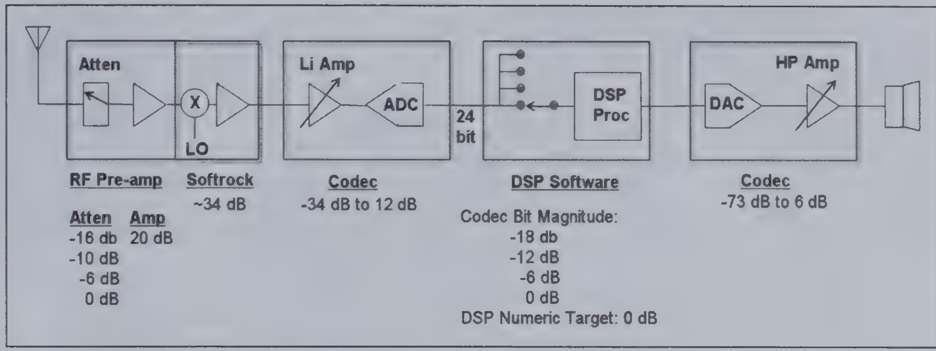


Figure 4—System gain distribution.

Real-time bandscope—This is a feature that we are quite proud of, and one which we think makes the SDR Cube stand out in a crowd of simple embedded SDR solutions. Besides being "sexy", a live spectrum display showing all signals within the 8 kHz RF swath being processed by the Cube can be a very useful indicator for the operator. One can "see" nearby signals that might be of interest for contact or listening. And the characteristic wave shape of the spectrum signal is often a good indicator of the signals mode, which can be very helpful when operating the digital modes.

We added the ability for the user to select (in the Configuration Menu) the desired type of FFT algorithm: Hanning, Blackman or Rectangular. The computation is a 128-sample complex FFT, as performed with the (corrected) Microchip DSP library functions. We need the log() function to display the bandscope, which happens to be our only execution-optimized function. The whole process takes only 650 μs.

Calculating the FFT from the complex data yields both positive and negative frequencies. FFT results are produced for LO + 4000 Hz and also LO – 4000 Hz, which in the real world translates to having a ±4000 Hz band scope. The LO (dial frequency) is at the center, translating to 0 Hz audio, with USB to the right side of the center point. LO + 4000 Hz is at the right corner. LSB is on the left side of the center point, and LO – 4000 Hz is at the left corner. Display marker dots are shown at 1 kHz points. Fast attack and slow release of the display filter makes it easy to visually follow signals.

State-of-the-art CW keying and wave shaping—Many PC-based SDRs have difficulty with fast transitions between Rx

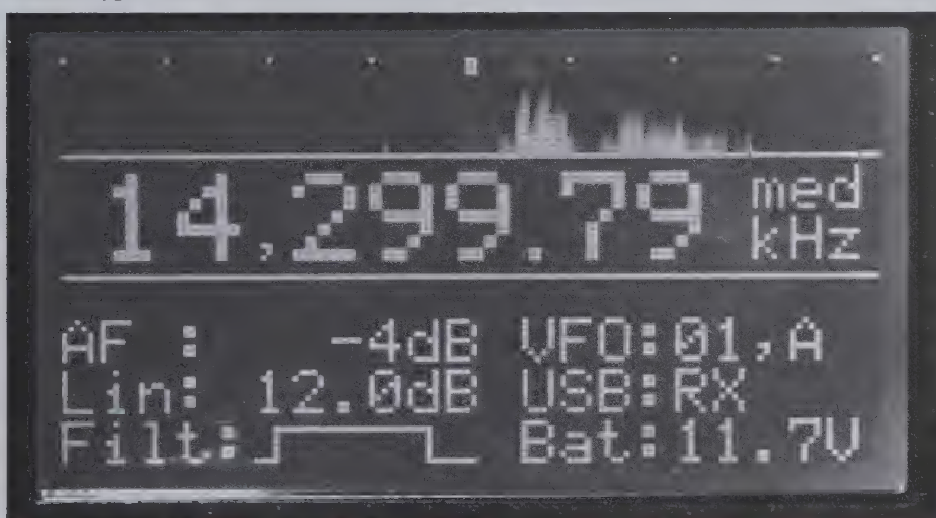


Photo 3—Live bandscope view on the SDR Cube display.

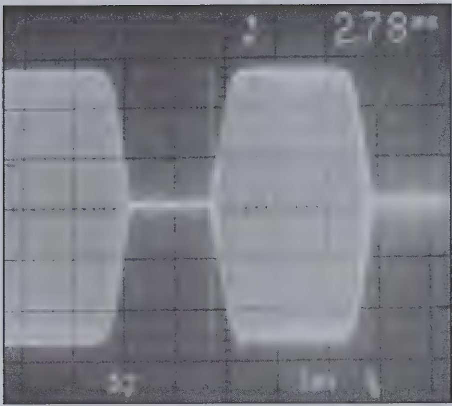


Photo 4—Sinc function applied to keying envelope on leading and trailing edges reduces energy at the transitions (clicks) and provides for a pleasing signal.

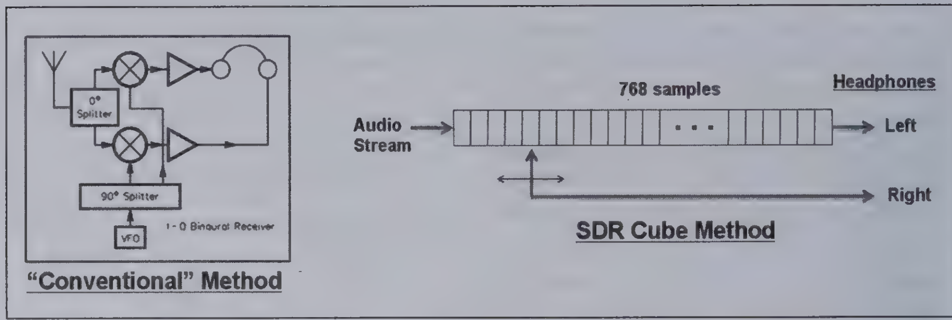


Figure 5—Quasi-binaural audio implemented in the Cube. A time delay is used instead of sending I and Q signals to each ear.

and Tx while in CW mode. “QSK” becomes hard to successfully implement when many layers of complex Windows software are used in processing the signals. However life on the embedded “bare metal” SDR Cube is quite different… we have virtually no delay from key down to RF, because we use a “software DDS” function to generate the sine and cosine carrier signals for I-Q direct feed to the Softrock. Thus for a Cube user to break in, there is only 20 ms lag (our receive path), and the transmit side is immediate!

Another CW feature is our sinc ($\sin(x)/x$) shaping of the CW edges... smooth and glitch-free as silk.

So in addition to the 0-100 wpm keyer, adjustable sidetone frequency, 300 Hz filter, adaptive Rx changeover delay, sinc waveform shaping, and Iambic-A, -B or Dot priority keying, we also probably have the fastest DSP CW processing in the market.

Binaural audio—Many ops feel that one of the most pleasing and useful audio features available uniquely on I/Q-based radios is that of binaural audio. As Rick Campbell, KK7B demonstrated in his seminal *QST* article in 1999, “the sound of CW signals on a binaural I-Q receiver is like listening to a stereo recording made with two identical microphones spaced about six inches apart. The same information is present on each channel, but the relative phase provides a stereo effect that is perceived as three-dimensional space.” The SDR Cube does not implement binaural audio in this conventional manner, as illustrated on the left in Figure 5; but instead we approximate the effect by implementing a simple and adjustable 768-word delay line, as show on the right in Figure 5. Samples are shifted in and out at a 125 µs rate (8 kHz), and the maximum binaural delay is 768×125 µs = 96 ms. The operator can adjust the delay from the menu in 1 ms steps to give the received signal a depth and richness that must be experienced to be appreciated. CW signals seem like they are traveling through your head, from one ear to the other, while tuning a station!

“Once my ears got used to the effect, they had to drag me away from this radio. This is one I gotta have!”—Ed Hare, W1RFI, ARRL Lab Supervisor…. *QST* March 1999, Rick Campbell KK7B article: “A Binaural I-Q Receiver”

Mechanical Construction

The SDR Cube design is comprised of three printed circuit boards, as depicted in Photos 5 and 6. The Controls board is oriented behind the front panel of the enclosure and contains all the user controls, graphics display, and clock generation options. The DSP board plugs into the end of the Controls Board at a right angle and sits front-to-back along the left side of the enclosure. And the I/O board plugs into the DSP card and contains most of the electrical connections to the outside world. An inner L-shaped aluminum bracket, serves to shield the digital environment of the Cube electronics from the RF compartment in which the Softrock resides. This RF compartment is sized to ideally contain the Softrock RXTX 6.3, however other electronics (or an entirely different Softrock transceiver) may be fit into this space. The custom-designed 4 x 4 x 4 inch aluminum enclosure is a clamshell to facilitate easy access to the inner workings of the Cube during assembly, troubleshooting or modification.

In Reflection

Software defined radio is a relatively new topic in the amateur radio community, and one that is extremely exciting with many barriers regularly being broken. Perhaps the most enticing is the “embedded SDR” barrier, whereby designers are now starting to break free of the artificial limitations imposed by bloated and lethargic PC operating systems that cripple the very technologies which we seek to push forward. By instead approaching an SDR solution on the “bare metal” of an embedded DSP architecture, we are able to more quickly achieve our design goals, and do it in a more comprehensive manner.

The SDR Cube Transceiver is among the first of its kind, providing performance-oriented SDR in an affordable, modular and extensible fashion. Built initially upon the ubiquitous and wildly popular Softrock “RF front ends”, the open software Cube design is applicable to thousands of hams worldwide… and we eagerly anticipate novel applications of it going forward. Whether it is the addition of a truly high-performance RF deck, or the tight integration of digital mode processing, or someone's clever packaging to more easily take it to the field, we look to the future with pride and confidence.

But of all our excitement and feelings of accomplishment, we believe the most notable achievement with the SDR Cube is making SDR look and feel like a real radio, while simultaneously untethering the radio from the grips of the dreaded and unnecessarily complex PC. To again paraphrase Alfonso Bedoya in the 1948 classic movie: The Treasure of the Sierra Madre… “We don’t need no stinkin' PC!”

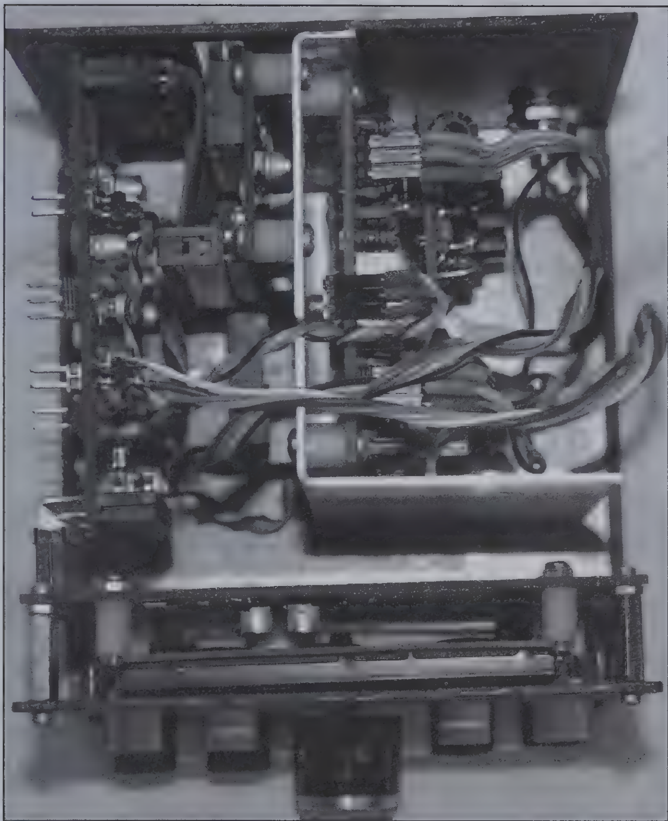


Photo 5—Inside view of the SDR Cube from the top.

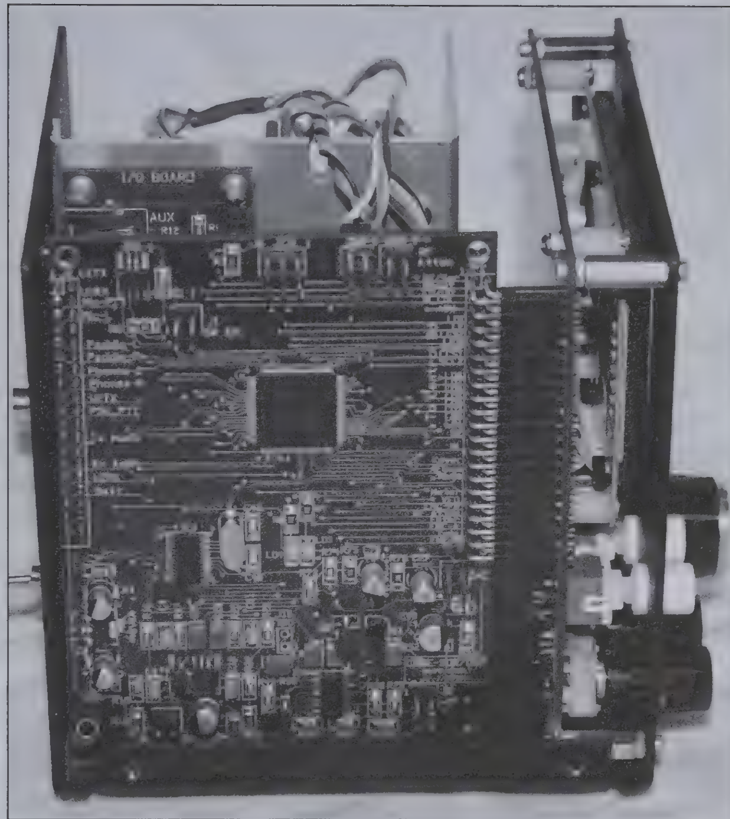


Photo 6—Inside view of the SDR Cube from the side.

About The Designers

George Heron, N2APB, is a cyber security professional helping to protect computers and users from the ravages of viruses and other malware. First licensed in 1968, George holds an Amateur Extra class license and is an avid homebrewer in RF and digital circuits, with special interests in DSP and microcontroller applications to QRP. His design accomplishments include the NUE-PSK Digital Modem, the Micro908 Antenna Analyzer, the DDS-60 Daughtercard, and other QRP kits. He co-leads the New Jersey QRP and the American QRP clubs, and has previously edited/published *Homebrewer Magazine*. George can be reached at 2419 Feather Mae Ct, Forest Hill, MD 21050, or at n2apb@midnightdesignsolutions.com.

Juha Niinikoski, OH2NLT lives in Espoo, Finland (near Helsinki) with his wife and two sons—one son is also a ham! Juha is a co-owner of a small hardware and software design house and is a co-developer of the Finnish JUMA kit line of ham radio products. Juha enjoys rag chewing and especially experimenting with new technologies and designing equipment. He received his first license in 1988; a Technical class license which was later upgraded to General class. OH2NLT can be reached at Etuniementie 11 C, 02230 Espoo, Finland or at juha.niinikoski@sitecno.fi.

References

1. SDR Cube website, http://www.sdr-cube.com: contains schematics, photos, parts lists, kits and all other technical information

2. SDR Cube on Yahoo Groups, http://groups.yahoo.com/group/sdr-cube/ — an active email list

3. CheapDSP, Juha Niinikoski, OH2NLT, http://www.kolumbus.fi/juha.niinikoski/Cheap_dsp/Cheap_dsp.htm

4. FlexRadio, Gerald Youngblood K5SDR, http://www.flex-radio.com/Default.aspx

5. NUE-PSK Digital Modem, George Heron, N2APB and Milt Cram, W8NUE, http://www.nue-psk.com/

6. Wes Hayward, W7ZOI, Rick Campbell, KK7B, Bob Larkin, W7PUA, *Experimental Methods in RF Design*, Chapter 11, http://www.qrp.pops.net/emrfd.asp

7. *The ARRL Handbook*, American Radio Relay League, http://www.arrl.org/shop/The-ARRL-Handbook-for-Radio-Communications/

8. Various articles in DSP Processing, ARRL, http://www.arrl.org/dsp-digital-signal-processing

9. High Performance SDR (HPSDR), http://openhpsdr.org/

10. HPSDR Boards, TAPR, http://www.tapr.org/kits_vna.html

11. *RSGB Radio Communication Handbook*, Radio Society of Great Britain, http://www.vhfcomm.co.uk/rsgb-handbook.htm

12. Softrock Transceivers, Tony Parks, KB9YIG, http://www.kb9yig.com/

13. Softrock RXTX V6.3, http://www.wb5rvz.com/sdr/RXTX_V6_3/

14. SMT Soldering Tools and Process, Cash Olsen KD5SSJ, http://kd5ssj.com/index.php?option=com_content&view=article&id=125&Itemid=129

15. Phil Harman VK6APH on AGC, http://support.flex-radio.com/Downloads.aspx?id=98

16. Sabin on AGC, Excerpt from *HF Radio` Systems and Circuits*, http://www.ab4oj.com/icom/agc.pdf

QRP Clubhouse

TimStabler—WB9NLZ wb9nlz@yahoo.com

Hello to everyone. I was asked when I got my right knee done last year when I was going to get the left knee done. I replied "when Hell freezes over". It froze over in September when I was told I had bone on bone in that knee. So, the left knee was done and I am now in therapy with the same therapist. Each session, I give her static and she does the same right back at me.

In my last column, I put in a letter from the Club 72 in Russia. Their website is at www.club72.su and is in English.

San Antonio QRPadillos group

I believe I mentioned the San Antonio QRPadillos group in my Summer column. They have grown to 60 members including 4 from foreign countries. They are still looking for more locals to join the group. Right now they are starting CW classes, both for the beginner and those who want to increase their skill level. They now have a website at: http://groups.yahoo.com/group/QRPadillos/.

4SQRP and Ozarkcon 2011

After a number of years of dedicated service to Four States QRP Group and OzarkCon as the web-master, David Bixler (WØCH) decided to open the door and let someone else also enjoy the thrill and excitement of serving the groups in this capacity. After receiving a cold call from Terry Fletcher (WAØITP) fishing for a new warm body, and a few days of shallow thought (I have been told hillbillies don't think very deep), David Martin, K5DCM, decided to try and help the effort for the Web Sites of www.4sqrp.com and www.ozarkcon.com

Next it was time to start preparing for the coming (2011) OzarkCon event in Branson, MO, April 8 and 9. For the coming year, people registering for the event will register online and have the option to mail-in their payment (involving the usual delays with that method) or pre-pay using PayPal. Using the PayPal method expedites the process and your registration will be automatically added to the attendee list as soon as confirmation is received from PayPal.

As you are reading this, the Ozarkcon website (www.ozarkcon.com) for Ozarkcon 2011 should be up and running. Everything that will be going on should be listed including the Friday night dinner, the Friday night building session hosted by the Midwest Homebrewers and QRP Group and the Saturday breakfast and the agenda for the day. Pictures from last year, a listing of Branson attractions and restaurants, a Branson map, and other websites you might want to look at will also be available at the Ozarkcon site. If you play something, bring it along and join our Friday and Saturday night "jam sessions" (pick 'n grin, bluegrass, Western, etc).

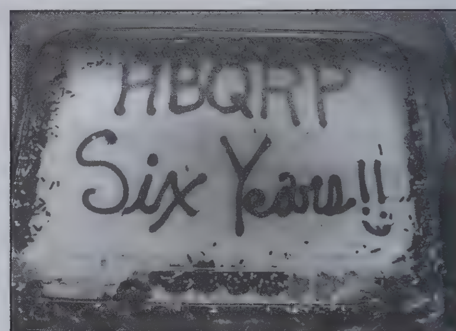
Stonecastle Hotel, site of Ozarkcon 2011 (and 2012-2015).

You should also be aware that the hotel, the Stone Castle Hotel, will allow attendees to stay an additional 5 nights at the special rate for the attendees at Ozarkcon. If you cannot make it this year, the 4SQRP group has Ozarkcon booked in for the next four years at this hotel. Dates are listed on the Ozarkcon website.

Midwest Homebrewers and QRP Group

The Midwest HomeBrewers and QRP group met on Saturday, November 6, for their 6th anniversary get together. There was Cake! The following folks were present, Dar W9HZC, Ray N5SEZ, Don ACØTS, Steve WBØQQT, Brian KMØY, Arnie KAØNCR, Joe KØNEB, Larry N2ZHK, and Bill KCØAVZ. If there was anyone there who is not listed then they forgot to sign in.

Working on projects were, Joe KØNEB, his project was the NADC40 and seemed to be going well. Larry and Don were working on an S9 kit and were soldering in the crystals when they were checked on. Dar Piatt, W9HZC, brought in several sample audio circuits for folks to examine for possible use in the group's ARRL SSB rig project. The Group had decided last meeting, October, to attempt to enter the ARRL build contest and shoot for a SSB, 10 meter rig. Members are taking assignments on which modules to work on. The Group will their best to meet the ARRL deadline but if they do not, they have voted to continue the project to the end and produce their own little rig, no matter what. Dar, W9HZC, is thinking 2011 will be a busy year for the group. Folks who struggle with design issues, will be soldering and testing modules.



Every birthday needs a cake!

The group will be monitoring/hosting the Friday Night Build-A-Thon this year at Branson for OzarkCon. The project will be a Soldering Iron Heat Control box that can be reproduced buy purchasing parts at any Lowes or Home Depot store. Plug in any soldering iron up to 100 watts and use the dimmer box to control the settings yourself. Neat and simple. No kit builder should be without one. For more info, check the 4State QRP site or www.hbqrp.org .

The group also plans to have at least 2 Lark-In-The-Park Saturdays and will post the information on their site soon. With any luck, several of the members should be on the air over the LobsterCon weekend and for 1DIJ (One Day in July).

The Midwest HomeBrewers and QRP group enjoys cake...

...and likes building things, too.

NJQRP Club

George Heron, N2APB, asked if I would put this in my column. Since I knew and talked with the SK and feel every group has at least one, I agreed. Here is the note from George:

"I am very sad to report that this week saw the passing of a good friend and stalwart supporter of the NJQRP Club from afar, Mr. Tom Feeny W8KOX.

Tom and his wife Nancy (NJ8B) of 54 years have been a part of the mind and soul of the NJQRP since the early days of Atlanticon some 12 years ago. Some will recall seeing this very unassuming couple walking slowly arm-in-arm throughout all our weekend events, participating in the code contests, the hidden transmitter contest, the PSK31 decoding contests and more. Together they built every single one of the 50+ different kits and projects we've produced over the years. And throughout their many years with us, unbeknownst to almost anyone, they helped Joe and me develop, kit and ship many of our club projects to destinations all around the world.

We will dearly miss Tom, but I think he will still be looking over our shoulders and guiding us as we continue designing and building our QRP projects going forward."

—George N2APB

Again, information from clubs and groups has been slight. Please be aware that I need club information 6-7 weeks ahead of your getting this publication due to editing, publication timing, etc.

Also, if you might want an email of the QRP club listing that was published here about two issues ago, so you can download it to a disk or whatever, please let me know and I will send it off to you, especially if you can give me club information (and hopefully pictures—with captions) I can use here. Send your Clubhouse submissions to me at wb9nlz@yahoo.com

Take care and with the snow get those projects built. My project is my basement room (shack, etc) getting built. Now that the golfing season is over, my father-in law and his friend should show up. They have done both of their entire basements, so my "room" should be no problem.

—72, Tim WB9NLZ

Upcoming QRP Contests:

2 & 3 April 2011	**Spring QSO Party**
29 May 2011	**Hootowl Sprint**
25 & 26 June 2011	**milliWatt Field Day Contest**
10 July 2011	**Summer Homebrew Sprint**

Mark Your Calendars!

VHF QRP: Beating the VHF Doldrums

James Duffey—KK6MC JamesDuffey@comcast.net

**Beating the VHF Doldrums—
What to do when the bands are dead?**

We are in the VHF doldrums. The winter Sporadic E (Es) season, although not as long and intense as the summer Es, is over. The January VHF contest is over and there is little contest activity until the Spring Sprints and the June contest. There are no major meteor showers until late spring. The cold weather of winter and early spring is terrible for troposcatter. Even aurora is usually most common around the equinox. With low effective power, life above 50 MHz in these months is even more difficult for the QRP VHF operator. So what is the QRP VHF op, or any VHF op for that matter, to do in these months of low VHF activity? Here are some suggestions.

Support your local VHF Activity Night

Most locales have a weak signal VHF activity night. Although times and frequencies vary from locale to locale, the usual routine is to hold the activity night at 8:00 PM local with six meters on Sunday, two meters on Monday, 222 MHz on Tuesday nights, 432 MHz on Wednesday nights and the higher bands on Thursday nights. Ask around for specific times and frequencies as they can vary from one region to another. Your SCM and the section web pages are a good source for times and frequencies in your area, or ask at the local club or on the local repeater.

Net formats vary a lot, from people just showing up to chat to someone with a big signal and good ears coordinating activity, to fairly formal nets, but the typical weak signal activity night loosely takes the form of a net, with the net control or coordinator asking for check-ins, having a go around, and then will "box the compass" going to certain directions at certain times to ask for check-ins. Boxing the compass with everyone listening gives the weak or long distance stations a chance to be heard. The coordinator or net control usually has a pretty well equipped station and can hear and be heard pretty well, but others can pick up stations that the net control will miss. Because of the high directionality of VHF antennas, you may have to call a few times or wait until the net control is pointed in your direction to be recognized. Be patient, you are likely to be heard and if you check in often, others will begin to point their beams your way and listen for you.

The nets are good places to ask about technical issues and operating techniques, share your accomplishments, find out about portable activity, as well as finding out who is going to be active for upcoming events. It will also give you a good idea about the capabilities of your station as well as a chance at long haul QSOs. Depending on the locale and conditions, coverage can be out to 200 miles or so.

Get on a new band

It used to be that the most common VHF band in weak signal use was two meters, but as more and more HF rigs now include six meters, six meters rivals two for most popular VHF band. If you are stuck on one or two bands, now is a good time to expand your station to other bands. More bands mean more chances for contacts and more points in contests.

If you don't have capability on six or two, you should add them before venturing higher. Next in order of popularity is 432 MHz, and then it is a tossup between 222 MHz and 1296 MHz.

You may well have a rig capable of operating another band, such as the FT-817 or Ic-706, but don't operate that band. In that case, all you need to do to get active on another band is to add an antenna and feed line. The WA5VJB antennas I recommended in the last column are a good, easy, and cheap way to get on two meters and up. So are the Quagi design by N6NB. For six, a Moxon is a good place to start. While RG-213 is OK for feedline on six and for short runs on two, lower loss coax such as LMR400 is preferred on 222 MHz and 432 MHz.

If you don't have a rig, you can build or buy rigs or transverters to get on a new band. I won't spend much time on new rigs, suffice it to say that Down East Microwave, Elecraft, and Yaesu all make QRP weak signal gear and Icom and Kenwood make VHF gear that can be run at QRP levels. The *QST* reviews of this gear is a better guide to this gear than I can provide. Also check with local users.

Building at VHF requires attention to layout, with short leads and stages shielded from each other to ensure stability, but it is certainly within the capabilities of the intermediate builder. KK7B has designed receive converters for six and two that convert to forty meters, and has matching VXO controlled 10 mW transmitters. KangaUSA has those available as kits at reasonable prices. If you like to build that is a good way to go. You will probably want to add an amp to those transmitters for serious work. K8IQY designed a simple six meter transverter as a companion to his 2N2/40 rig. The design is simple, composed of easily available parts, works, and is on the web. Several years back W1VT designed a nice three board no-tune 222 MHz transverter using common parts still available. FAR Circuits still carries boards for that design, which a number of people have successfully reproduced. It too is fairly low power and will benefit from an amplifier. W1GHZ designed a 222 MHz transverter companion for the FT817 a couple of years ago, but unfortunately, some of the parts he used are no longer available. It may be revived with new parts though, keep looking. W1GHZ has also designed low power transverters and matching local oscillators for 902, 1296, 2304, and 3456 MHz using commonly available parts. These are an excellent way to get on the microwave bands. W1GHZ has the board layouts available on his web site, and may have boards available from time to time. There are other designs in handbooks and on the web. Don't overlook the fine RSGB VHF and UHF publications when looking for projects.

Now is the time to scour hamfests and the usual on line ham gear ads for used six meter gear; when the band opens this spring the demand for six meter gear and the prices will both rise. Plus if you purchase now, it will give you time to get everything interfaced and

There is a lot of used gear out there that will enable you to get on another band and it is hard to make a concise list of recommendations. A word of caution though, VHF multimode rigs hold their value well, and it is often possible to buy a newer

multiband rig for the price of several older single band rigs. If you want to interface the rig to a computer, you will likely need a newer rig. There are some used rigs worth pointing out though: The ubiquitous FT-817 is available used at reasonable prices, often less than $400, is widely supported, can be run from batteries, even though it is a bit of a power hog, has computer interface capabilities. and can be easily used for a transverter IF for other bands. The Ten-Tec transverters are excellent values, of recent design, commonly available, and work well. The two meter version can be converted to 222 MHz with guidance from a *QST* article. Older Microwave Modules transverters and their Rochester VHF Group clones are common and inexpensive, but they are getting old, and their performance is not up to par with modern units. With the six meter and two meter Ten-Tec transverters available at nearly the same price as the Microwave Modules units, only the 222 MHz (rare), and 432 MHz versions are really worth considering. I like the early 80s FT480R, FT680R and FT780R rigs from Yaesu; they offer 10 watts out, the VHF QRP limit, are reasonably priced, straight forward to operate without a manual, have reasonable sensitivity, are reliable, have the controls well separated, and if you are interested in satellite operation, allow you to do FM in 1 kHz steps. The Yaesu FT690 MKII, FT290 MKII, FT490 MKII series are work horses and available, but at a price. They have a mediocre front end, though, but with the attached battery pack make a nice portable combination. Be aware that if you want to get on two or more new bands this way, a used FT-817 can be had for less than the price of two of these rigs, and a new one for not much more and certainly less than the price of all three, and offers better capabilities to boot. The Icom IC-502, IC-402 and IC-202 rigs are popular among lots of VHF portable ops, but they are getting long in the tooth and a bit hard to find. The 202 is a popular choice for a microwave IF. The earlier FT690, FT290 and FT490 rigs are also available and are nice portable rigs, but the prices are not much lower than their MKII cousins and the performance is somewhat worse.

Monitor the bands

It is easy to miss the first Es opening of the year. We all know that six can open anytime, so it pays to listen on the calling frequency and for the beacons, even on a dead band. If you have a beacon within range, it is educational to listen for it and see how the signal level changes with time of day, weather, and other influences. Beacons that are normally just barely readable are the best for this purpose as the changes are more pronounced. If you have a computer with spectral analysis software hooked up to your rig, you can quickly jot down the signal-to-noise ratio for future reference and analysis. Beacons are found between 50.060 MHz and 50.080 MHz, 144.275 MHz to 144.290 MHz, 222, 432 . A map with six meter beacon locations in the US can be found here:

http://www.k9mu.com/map/

And a list of worldwide six meter beacons here:

http://www.keele.ac.uk/depts/por/50.htm

Beacons on two meters and up are listed here here:

http://www.newsvhf.com/beacons2.html

For non-electromagnetic means of determining band openings, point your browser to DX Sherlock:

http://www.vhfdx.info/spots/map.php?Lan=E&Frec=50&ML=M&Map=NA&DXC=N&HF=N

Check this web page when you log into your computer for up to the date VHF spots plotted on a map. It also calculates and plots where the E Clouds are and the MUF for each cloud.

Get on the Satellites!

There is a lot of overlap in a station required for amateur satellite operation and a good weak signal VHF station. If you have not operated the satellites, you are missing out on a lot of fun and you may well have most if not all of the equipment required. Most current satellites are accessible with 10 Watts or less to a 2 or 3 element Yagi, and some can be worked with much less power and a simple vertical. There are several types of amateur satellites operating, in general, there are the FM satellites which receive a single FM signal up on one band and retransmit it down on another band, there are linear satellites that take a band segment tens of kHz wide at one frequency and retransmit that segment at another frequency, and digital satellites that take a digital signal, store it on board, and download it on request. If you have not operated the satellites before, check the AMSAT web page:

http://www.amsat.org/amsat-new/index.php >

There are several good pages on starting out. The first thing to do is listen. Choose an active satellite; the AMSAT web page will help here. You will need to know when the satellite is visible and can be heard. The AMSAT page also has a satellite tracking page that will tell you this if you know the latitude and longitude of your location, or you can use a standalone program. It is easier to do this when you start by using an omnidirectional antenna and then graduate to pointing your directional antenna. Oh yes, you also need to compensate for Doppler shift, so the frequency you hear will not generally be the exact published frequency. The Doppler shift is worse at higher frequencies. You may quickly come to the realization that one needs to be an octopus to operate the satellites. When you have mastered all this, try transmitting and listen for your downlink. This adds another variable, compensating for Doppler on the transmit. If you get serious, you can get a computer to do all this for you. You should be a good neighbor on the satellites. If you operate the FM birds, only one station at a time can have a QSO, so don't hog the satellite. If you operate the linear satellites, try to do at least minimal Doppler compensation on the highest frequency so that you don't shift to QSOs already in progress. Ideally one should tune both the transmit and receive to compensate for Doppler, but this is difficult if not impossible to do without a computer.

Upgrade your station

Now is a good time to upgrade your station as you are less likely to miss an opening having it down for upgrades during late spring and early summer. Better to have the station in disarray now than in the middle of the Es season. There are several things one can do to improve your station.

While some of these suggestions are small changes, several of these small incremental changes can add up to a noticeable change in station performance. Here are a few places to start:

Rejuvenate or upgrade antennas

If you are using a loop, going to even a small beam will make a huge difference in what you can hear and work. A Moxon on 6M or a WA5VJB Yagi on the higher bands will really increase the distance you can work over a halo or other half-wave loop. If you have the longest WA5VJB Yagis up and are serious about VHF, perhaps now is the time to upgrade to a long Yagi. Shoot for a Yagi with a 12 ft boom. That is a manageable size with a noticeable improvement in performance over the longest WA5VHB designs, and the boom can be made from two 6 ft pieces of aluminum, the longest length that can be easily shipped. DK7ZB has good reproducible designs, as does YU7EF, and the venerable DL6WU and K1FO designs are still good. Of course you can buy an antenna, but that is not nearly as much fun is it?

Replace Feedline

Feedline loss hurts two ways. The losses decrease your effective radiated power hurting your signal at the receive end, and on receive the feedline loss translates directly into reduced sensitivity through an increase in the noise floor. I try to get my feed line losses down to 0.5 - 1.0 dB, favoring the low end, but tempered with the price. My thought is that 1 dB is about the most the human ear/brain can discern, but after accepting several 1dB losses in this manner pretty soon half your power is gone. So it is best to err on the low side. You can measure your feedline loss with an antenna analyzer, if you know what the antenna impedance without the feedline is (you wrote that down in the log when you erected the antenna right?) and feedline loss data is available in the handbook and on the web. If your feedline loss is greater than 1 dB or so, it is worthwhile to install lower loss coax. If you are using RG8X or smaller on 2M and higher, you will most certainly want to change it out. Same with RG-213 on 432 MHz. LMR400 or equivalent is a good choice as it is fairly low loss to 432 MHz, and is not exorbitantly priced. The length of your feedline run obviously matters, with shorter runs of coax one can obviously get by with feedline that has higher losses. Feedline is not cheap, but in portioning costs in a station, 10% to 15% of the total cost for feedline and connectors is reasonable.

Install Preamps

Excellent low noise receive capability is the key to good VHF operation. You can't work them if you can't hear them, and most commercial VHF rigs on 2M and up have enough excess noise that they can benefit from an external preamplifier, particularly if you plan to operate in the field, where noise is typically low. A low noise external preamp will help you get the most of your receive setup. Reasonably priced commercial RF activated relay switched preamps are available from Advanced Receiver Research at reasonable prices and will handle QRP levels quite nicely. Preamp kits are available for six, two, 432 MHz, 1296 MHz, and 2304 MHz from Mini-Kits in Australia.

http://www.minikits.com.au/kits2.html#eme173a2

They will ship to the US and take PayPal or a bank draft in Australian dollars for payment. They have other kits of interest to QRP VHFers, including power amplifiers that are good matches to the KK7B kits. The grounded gate JFET preamp is easy to build and performs well for terrestrial use through 222 MHz. There are several basic designs around and they were included in older Handbooks. N6CA has a nice design on his site:

http://www.ham-radio.com/n6ca/50MHz/50appnotes/U310.html

He gives design information for six, two, and 222 MHz preamps. Unfortunately, the U310 that he uses is no longer being fabricated and available stock is quite expensive. The much less expensive J310 can be substituted with little loss in performance, but be sure that you shield the input from the output if you use it. The U310 is in a metal can and inherently provides this shielding.

Add selectivity

CW adds 10 dB to your station capability and having a narrow CW filter available helps you copy CW under weak signal conditions. If your radio has an unfilled CW filter slot, add a CW filter. If you can't add selectivity at the IF, and most older VHF radios can't, add an audio filter. The New England NESCAF filter kit is an excellent choice at a modest price and should be available. There are lots of older audio filters available as well at hamfests.

Interface a computer with your rig

Having a computer interfaced with your rig brings a whole new toolbox to your VHF operations. With a computer you can use spectral analysis, automate CW sending, have a voice keyer, and dip your toes into the digital modes such as WSJT. For serious contesting, a computer is a must. Exact configurations will depend on your computer and rig and can be as simple as just hooking the audio out from your computer to the microphone in of your rig and the speaker out from your rig to the audio in on your computer. If you have hum and noise problems, use transformers. Look on the internet for other suggestions. Commercial interfaces are available ranging from very simple to fairly complex. I expand on all this in a future column on the use of a computer at VHF.

Give 10m a Whirl

OK, so ten meters is an HF band. Well yes and no. Just as six meters can act like an HF band when the solar flux is at its peak, ten often acts like a VHF band, namely six meters, particularly when the solar flux is low. The two bands share more in common than one would think. Sporadic E (Es), aurora, and meteor scatter are all available on ten. Thus, operating on ten can give you a bit of insight and experience for six meters. Sporadic E is more common on ten than on six, and often ten is open on Es when six is not and Es on ten can be a precursor to Es on six meters.

Fills

In the last column I mentioned that I used MathPad for path loss calculations. As it is a Mac program, I did not think many would be interested in it and hence did not include a source, but I have had several people ask me about it. MathPad is free, and available from:

http://pubpages.unh.edu/~mwidholm/MathPad/index.html

There are several plug-ins available, including one for plotting SPICE output files. MathPad is probably best described as a graphing calculator, but it is capable of very sophisticated calculations and produces very nice customizable plots. It is similar in concept to MathCad, if you are familar with that program, but it has a much better user interface, at least in my opinion. If you use it for a VHF, QRP, or general Ham calculation, let me know.

Getting started in VHF QRP

KØNR has an excellent tutorial on getting started on QRP VHF on the web:

http://www.rwitte.com/vhfqrp.html

Bob preceded me in this column and I can do no better than to recommend his tutorial on the web to the newcomer.

Your Input is Wanted

This is a reader's column, so your input is invited. If you want to see a specific topic discussed here, let me know. If you have something interesting to share, but don't want to write a full fledged article for *QQ*, let me know and we can put it here. If you have pictures of interesting QRP VHF activity, send them along. Homebrew projects are always welcome.

Coming Attractions

The next *QQ* will be out in late April or early May and as that coincides with the beginning of the summer Es season, I will discuss Es in the column; how to get on six if you are not already on six, and general strategies for working Es. Look for it!

I have received a couple of requests for columns on antennas, and a column on amateur satellites. Those are in the works as well.

Until next quarter, listen for the weak ones! ●●

HF Bicycle and QRP Pedestrian Mobile

Dave Starkie—G4AKC

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HF bicycle mobile may seem like a strange mode of transport for HF amateur radio communication, but for many years I have been operating HF car mobile close to the sea and I have always had good results due to the enhanced ground-plane of the saltwater. However I could never get really close to the waters edge with the car as I was restricted to access via roads and tracks.

So a few years ago I decided to put an old Yaesu FT-817 on my pedal bike using a short home made centre loaded vertical for 14 MHz fixed to the back of the bike and just running 2.5 Watts, and operated from the promenade in Blackpool very close to the sea.

Using the low power and operating at the waters edge, I managed several contacts into the USA with good signal reports. Even running QRP the performance when riding close to the sea was outstanding!

I was now truly hooked on operating HF Bike Mobile close to the sea.

The bike itself is an inexpensive 16-speed mountain bike. It is now equipped to operate on all HF bands using the call sign "G4AKC/bicycle mobile" whilst on the move, mainly from locations very close to the sea in Blackpool near to where I live.

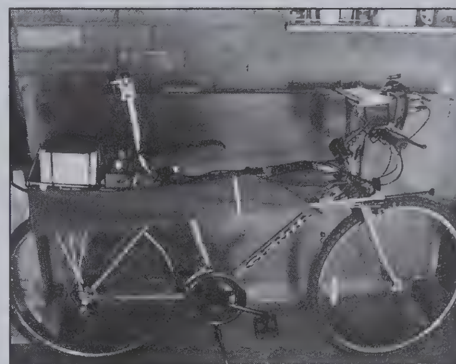
The radio I use now is a fixed handlebar mounted Alinco DX-70TH in a zipped waterproof cover (in case of a downpour), the radio is powered by two pairs of selectable 7 Ah 12V gel batteries. The Alinco DX70 has been modified to provide continually variable power from 10 mW up to a maximum of 50W output.

Dave, G4AKC/bicycle mobile.

To control the RF power output I apply a negative DC voltage onto the ALC line, this is clamped by a zener diode and fed into a potential divider to put between –3 and –4 volts onto the ALC line.

The on-board batteries give a total of about four hours of use at the maximum output power. Two of the batteries are mounted on the rear pannier and the other two batteries mounted under the cross bar.

Lots of RF toroid filters are used to eliminate RF feedback problems, because the antenna is only a short distance away from the transceiver.



Bike in the garage, ready for another bicycle mobile trip.

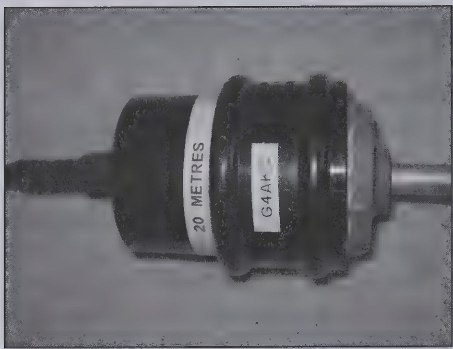
The antennas for 15,17,20 and 40 Metres are home designed and homemade Hi-Q mono-band top-loaded verticals, which are 3.5 m, long, and each has a dedicated 75 mm diameter air-spaced coil, they are stored for transport in the red side bag on the bike.

The latest bike "add-ons" include:

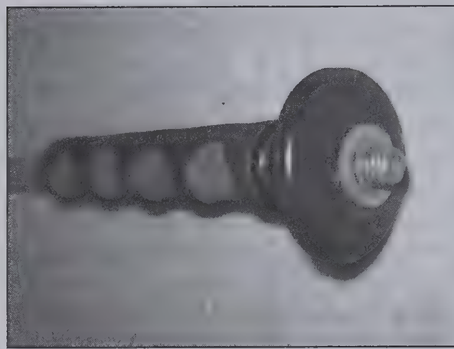
- Olympus digital voice recorder.
- Weather monitoring equipment, (so I know when it is going to rain!)
- Small Libretto computer with a dedicated logging program.

Antennas

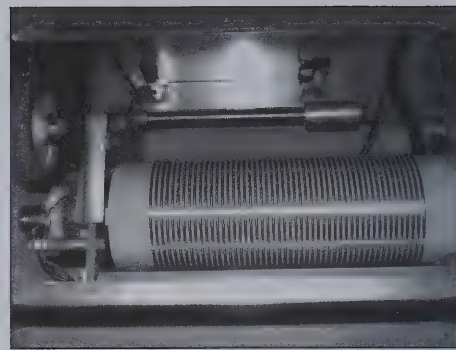
I usually carry at least three different antennas in the purpose made pouch on the



Antenna loading coil (20M).

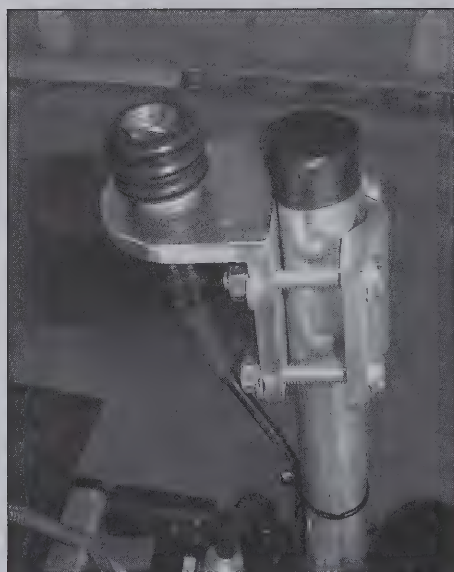


Antenna bottom view.



Inside the GTU enclosure.

Antenna in 3 easy to transport parts.



The bike aerial mount.

side of my bike for different frequency bands dependant upon propagation. The antenna's can be removed in seconds and stored in the pouch.

All antennas are homemade mono-band antennas and the most used antenna is a centre-loaded vertical, which is a total of 2.5 metres long, and this is constructed in two pieces for easy transport on-board the bike.

The lower half of the antenna is constructed from a 1.2 metre long piece of 10 mm hollow aluminium tubing available from large DIY outlets and this is permanently attached to the centre loading coil which is wound onto 75 mm diameter plastic drainpipe. The top section is a stainless steel whip, which is removable.

The antenna weighs only a few ounces and hence is ideal for operation whilst on the move and has very low wind resistance, so is suited to adverse weather conditions.

The bicycle is fitted with a standard mobile mount fitted to a "J tube" and the centre loaded vertical is attached to the base of the antenna by a piece of 3/8" threaded bar which is inserted into the hollow aluminium tubing and this is crimped and a locknut is fitted to prevent it coming loose.

The loading coil is made from 3 mm stranded cable and the number of turns is dependant upon frequency band it is made for.

The whole antenna is covered in heat shrink to protect it from the weather. The total parts cost for this antenna is around £10.

The antenna is initially constructed at home using an aerial analyser with the antenna working against a set of known resonant radials. The antenna is then placed on the bike or pedestrian trolley and the braid of the coax at the antenna side is not taken directly to ground, but via a tuned circuit then connected back to the chassis or frame.

When weather conditions permit, I operate with a top loaded vertical, which is more efficient, however it is a total of 3.6 metres long and can be difficult to control in windy conditions!

The construction is identical to the centre-loaded vertical but uses an additional 1.2 m length of aluminium tubing at the base which is threaded together to the centre loaded vertical. However the top stainless steel section is slightly shorter to maintain resonance.

Ground Tuning Unit (GTU)

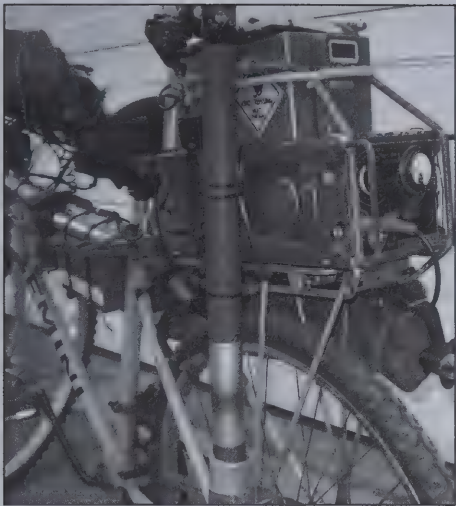
The limited size of the bicycle frame does not provide an ideal ground-plane for the vertical antenna to work against and as the bicycle is moving it is impractical to attach a trailing wire to the bike, however the sea provides a perfect ground-plane, all that is needed is a method to connect to this.

In order to couple in to the perfect ground plane of the sea with the bike, and also to provide a good RF ground current, the frame of the bike is tuned to resonance on the operating frequency. This is achieved by breaking the braid of the coax cable where it would normally connect directly to the frame of the bicycle.

The braid is then connected via the GTU (Ground Tuning Unit, as opposed to ATU), this consists of a roller inductor and switchable capacitor, and then the return side is then re-connected back to the bike frame.

This GTU is adjusted for maximum ground current, which can be quite high when operating near to the sea (and especially so when using the amplifier).

The GTU ensures that the bicycle is effectively coupled to the surrounding sea-



Equipment attached to the bike, with batteries under the crossbar, as well as in the metal box above the rear wheel.

20M pedestrian mobile package.

A closer look at the pedestrial mobile station, with Mizuho radio, GTU, and other operating gear.

water by the capacitance of the bike to the ground, regardless of the motion of the bike. It has to be manually adjusted to obtain maximum ground current when the ground conductivity changes. This is dependent on high or low tide and different types of ground. The GTU has an RF current meter built in. The performance of the whole system is greatly improved when using the ground tuning, especially when operating close to the sea.

The ground conductivity determines how much ground current is flowing and hence if the tide is in, the ground conductivity is increased. The ground tuning has to be adjusted dependant on the prevailing ground conductivity conditions.

A dramatic peak of both the received and the transmitted signal is achieved when the ground current is maximised when operating near to the sea.

Equipment

When on the move it is essential to have simple but efficient radio equipment.

The use of a simple headset keeps hands free to ride safely and simple to operate radio equipment like the Alinco DX-70th, which has very few second function buttons and menu operation to contend wit

The 12 volt DC supply required for the Alinco DX-70TH radio requires up to 20 amps peak current on SSB. In order to provide sufficient current for at least 2 hours continuous use I have two 7 Ah gel batteries in parallel attached to the crossbar on the bike and duplicate pair of 7 Ah batteries in parallel in a metal box on the rear of the bike that can be switched in to extend operating time, the total on board DC battery capacity is 28 Ah.

Location, Location, Location

The location is perhaps the single most important factor in getting good results, and here in Blackpool on the northwest coast of England I am very lucky to have a truly fabulous location for the HF bands when riding out on the bike. I am lucky enough to have a perfect take-off over the sea to the north, south and west, but I am screened by sand hills to the east and hence I can only work long-path into VK, ZL, and the Pacific area. I have excellent short-path results into North and South America. The saltwater of the sea creates a perfect ground-plane for the antenna to work against much like a sheet of copper stretching for many miles.

Operating near to the sea increases the ground wave and decreases the angle of radiation, increasing the performance especially for DX in the direction of the sea water.

The sea provides the perfect ground plane for the vertical antenna to work against, it creates what we have nicknamed "God's linear amplifier" on both transmit and receive!

QRP Solar Powered Pedestrian Mobile

The pedestrian mobile was constructed as an alternative system to get even closer to the sea and also to provide a more flexible system for practical use. The basic trolley frame is a lightweight easy to pull trolley or cart constructed from an inexpensive shopping trolley. The radio is a twenty year old Mizuho MX-14S 2 Watt SSB/CW 20M only transceiver.

The radio is powered by a 13W solar panel permanently fitted to the pedestrian trolley and relies completely on solar energy from the sun as there are no batteries fitted to the radio.

The output from the solar panel is fed into a 12V voltage regulator which provided 1A of current in full sun which easily powers the little Mizuho radio on both transmit and receive.

Using this set-up I have had ssb contacts into VK and ZL, on the 22nd of April this year I had a contact with John, ZL2JBR in Wellington New Zealand at a distance of 18,589 kM on just solar energy, the QSO was witnessed by Lee GØDBE.

The antenna on the trolley is a full size quarter wave wire supported on a 6M fishing pole and fine antenna tuning is made by the MFJ travel tuner as seen in the picture. The GTU on the pedestrian mobile is currently a MFJ ground tuner.

There is more information about HF bicycle and pedestrian mobile including recorded digital voice files on www.qrz.com/db/g4akc

How Good is Your Low-Pass Filter?

Dave Gordon-Smith—G3UUR daveg3uur@googlemail.com

There are a bewildering range of different low-pass filter designs around these days, and when it comes down to it the one you decide to use in the end may very well have more to do with the capacitor values than any performance figures. Certainly, some high-performance filter designs do have very odd capacitor values, but there's no reason why you shouldn't have both convenient values and good performance. That, however, usually requires something a bit out of the ordinary, especially if you only want to use one capacitor of a standard value (SVC) in each capacitor position without the need for any parallel combinations to make up awkward values. Before we get on to that, though, let's review some of the filter basics because getting enough harmonic suppression is not the only important aspect of low-pass filter performance.

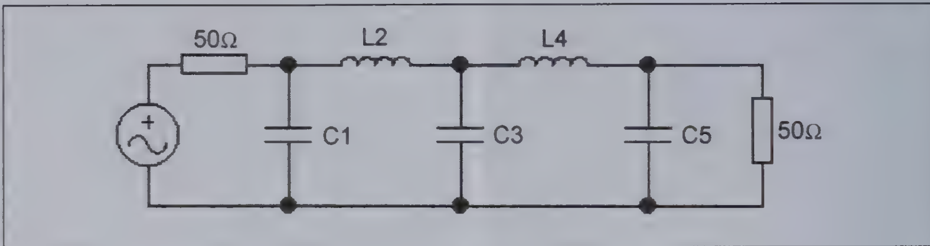


Figure 1—Standard Chebyshev low-pass filter: 5th order, pi configuration.

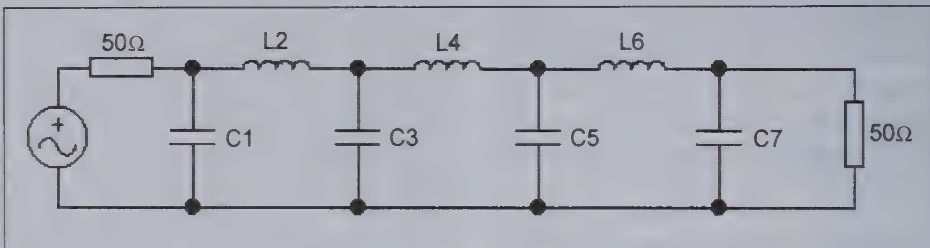


Figure 1—Add two elements to get a 7th order Chebyshev low-pass filter.

Filter Facts

There are many different types of filter, such as Bessel, Legendre, Gaussian, and Linear Phase, to name just a few. Generally, though, all but the Chebyshev and Cauer equal-ripple types can be ruled out for cleaning up harmonics from an RF power amplifier (PA). That's because most of the other types don't offer as much harmonic attenuation or have pass-band responses that provide a good enough match. Both Cauer and the Chebyshev filters have equal-ripple pass-band responses but they differ in the stop band. The 5th-order Cauer response has two transmission zeroes (notches) that can be positioned at the second and third harmonics to improve attenuation at these frequencies, but that requires an extra capacitor across each coil. Consequently, Cauer low-pass filters have more components than Chebyshev ones, and they have limited ultimate attenuation. We'll leave them out of the discussion for the time being, though, and come back to them later. The standard form of Chebyshev low-pass filter is shown in Figure 1. This is a 5th-order pi-configuration design and has 5 components. Increasing the number of components by adding one more series inductor and one more shunt capacitor increases the order to 7 and you get the circuit of the 7th-order low-pass filter shown in Figure 2. These additional components improve the amount of harmonic attenuation you get. Usually, for run-of-the-mill amateur work, 5th-order and 7th-order low-pass filters are used because they provide adequate attenuation for most applications.

Chebyshev designs offer more harmonic attenuation if the pass-band ripple is allowed to increase, but that comes at a price. The amplitude ripple has a corresponding VSWR ripple, and a properly terminated 1 dB-ripple design can have frequencies in the pass band where the VSWR rises to 2.66:1. This means that if you're unlucky and your transmit frequency coincides with a dip rather than a peak in the pass band, the PA could be delivering much less power than it should to the antenna, even though the antenna may be well matched to the low-pass filter. Not only that, the PA efficiency will also suffer because it's not seeing a resistive load, and it'll be drawing far more current than it should because the load is reactive. So, it's a double whammy because your battery will be drained at a faster rate than it should be and you'll get less power to the antenna as well.

Unfortunately, the only solution for Chebyshev designs is to use low ripple so the filters present the PA with a more acceptable VSWR right the way across the pass band when they're correctly terminated. This usually means going for designs with 0.01 dB or lower ripple, which don't provide anywhere near as much attenuation for harmonic suppression as high-ripple designs. So, in order to get more harmonic attenuation the order of the filter then has to be increased. So, you may need to use a 7th-order low-ripple Chebyshev design instead of a 5th-order to get adequate harmonic attenuation. If you're unsure of what you're currently using, there's a simple way of telling. Chebyshev filter circuits are symmetrical and referring to Figure 1, C1 is always equal to C5 and L2 is always equal to L4. Likewise, referring to the 7th-order filter in Figure 2, C1 is equal to C7, C3 is equal to C5 and L1 is equal to L6. The tell-tale sign is the ratio of capacitor C3 to capacitor C1. It's fixed by the design ripple, and for 5th-order 1dB-ripple filters this ratio is 1.40566. Lower ripple filters have higher ratios and for 0.1 dB it's 1.72217, going up to 2.0000 at 0.073 dB, and 2.0847 at 0.01 dB. So if the ratio of C3 to C1 is greater than 2.0847:1 in your 5th-order filter, you'll know the design ripple is fine for providing a good match to the PA. That doesn't mean to say that the load presented to your PA is close to 50 ohms though, because unless you've set up the inductance of the coils carefully you may not have an equal-ripple

Chebyshev response.

Should you want to design your own low-pass filter, and use only SVCs, you'll have to tailor the ripple to suit the ratio of the nearest pair of suitable capacitor values. The most convenient ratio above 2.0847 is 2.2, or thereabouts, and this happens to correspond to a ripple of around 0.005dB for 5th-order filters. Therefore, 5th-order Chebyshev SVC low-pass filters with a good match are a possibility, and can be designed around this value of ripple. The cut-off frequency may require some adjustment to get the values to coincide with SVCs, unless you're very lucky. Any compromise in the cut-off frequency, of course, lowers the harmonic attenuation a tad. By the way, 0.01 dB-ripple 7th-order filters have a C3/C1 ratio of 2.1936, so if you go for a ratio of around 2.2 to 2.4 for this order, the design should provide a good match to your PA.

Ripple	Refl. Coeff.	Return Loss	VSWR
1 dB	0.4535	6.87 dB	2.660
0.5 dB	0.3298	9.64 dB	1.984
0.2 dB	0.2121	13.47 dB	1.539
0.1 dB	0.1509	16.43 dB	1.355
0.05 dB	0.1070	19.41 dB	1.239
0.02 dB	0.0678	23.38 dB	1.145
0.01 dB	0.0480	26.38 dB	1.101
0.005 dB	0.0339	29.39 dB	1.070
0.002 dB	0.0215	33.37 dB	1.044
0.001 dB	0.0152	36.38 dB	1.031

Table 1—VSWR, return loss and reflection coefficient for 5th order Chebyshev low-pass filters with various ripple values.

Attenuation and Return Loss

How do you judge a good design in practice? Well, the amount of attenuation required at any frequency depends on the levels of the different harmonics produced by your PA, and that in turn depends on the type of circuit and the mode of operation. Push-pull linear amplifiers should be well balanced so that the second harmonic is well down on the third, but that's not always the case. Single-ended, non-linear amplifiers usually produce more third harmonic than second, though there's no guarantee that will always be the case. If you don't know what your PA is producing and can't measure it, the safest approach is to assume the second and third harmonics are both equally bad at around 10 to 15 dB down on the fundamental, and go for a design that gives at least 40 dB at the second harmonic if you're running up to 5 watts. This can be achieved with a 7th-order Chebyshev design of just below 0.01dB ripple. That'll ensure the match to the PA is fine as well as providing moderately good harmonic suppression. However, you may want to check out an existing unknown design to see whether it's any good. Very good harmonic attenuation can be provided by filters that are not designed for optimum power transfer, and these should be avoided. If the design is a poor one for RF power applications, you're not likely to get a good match to the transmitter across the entire band, or if it's really bad you won't get one anywhere! I've already mentioned ripple and VSWR variations in Chebyshev filters, but filter designers don't normally talk about mismatches in terms of VSWR, they use *Return Loss* instead. This is just a dB measure of how far down the reflected signal is on the incident power at the input when the filter is terminated with the right load—usually 50 ohms for RF applications. The greater the return loss figure is, the better the match, of course. As well as VSWR, Table 1 also shows the corresponding values of return loss for various degrees of ripple. Getting a high enough return loss in the pass band is essential for a transmitter low-pass filter.

Solid-state amplifiers are not usually designed to match a wide range of load impedances, and presenting them with the load impedance for which they were designed is the best way to ensure you get the optimum performance from them. Most RF amplifiers are designed for 50-ohm systems, and very often we use 50-ohm SWR bridges to check that the load presented to the low-pass filter is near 50 ohms. Have you ever checked what load your low-pass filter presents to your PA, though? Probably not! It's impossible to check this without a second low-pass filter or another well filtered transmitter, of course, because all harmonics have to be reduced to a very low level to get a true reading of what's happening at the fundamental. Most of our QRP transmitters are built on single boards incorporating the low-pass filter, so it's difficult to check separately anyway. Very often the most convenient approach is to check out an unknown design with a circuit analysis program before building it. A very handy program is available as a free download from the AADE website. You can check out both the return loss and the attenuation of any design with this software. Then, if it's OK, you can adjust the inductors in situ to minimise the PA power consumption after you've completed the project. This, of course, assumes that the capacitors are close enough to the right value, which they usually are if they're close tolerance ones. I've checked out a number of published designs, and it's surprising how many present a poor match to the transmitter!

Return loss and pass-band VSWR are the most sensitive measures of whether a filter is set up correctly. You can measure either to check out a filter, but obviously VSWR is easier to measure for most amateurs. RF amplifiers that are designed for a 50-ohm load need the load presented to them to be near 50 ohms, otherwise they dissipate more power than they should, the power output is lower than it could be, and in linear service the intermodulation distortion products may increase. Figure 3 shows the frequency response and return loss plots for a 0.01 dB-ripple, 5th-order Chebyshev design for the 160-meter amateur band. This level of ripple was chosen because it corresponds to a worst-case VSWR of about 1.1:1, which is probably about as high as you would want the mismatch between your filter and the PA to go without there being any noticeable effect on performance. The –3dB cut-off frequency for this filter is 2.582 MHz. It can be seen from the amplitude response in Figure 3(A) that the attenuation increases monotonically with frequency, so the higher harmonics are attenuated more than the lower ones. This is not really what you want, of course, because the PA normally produces harmonics that gradually fall off

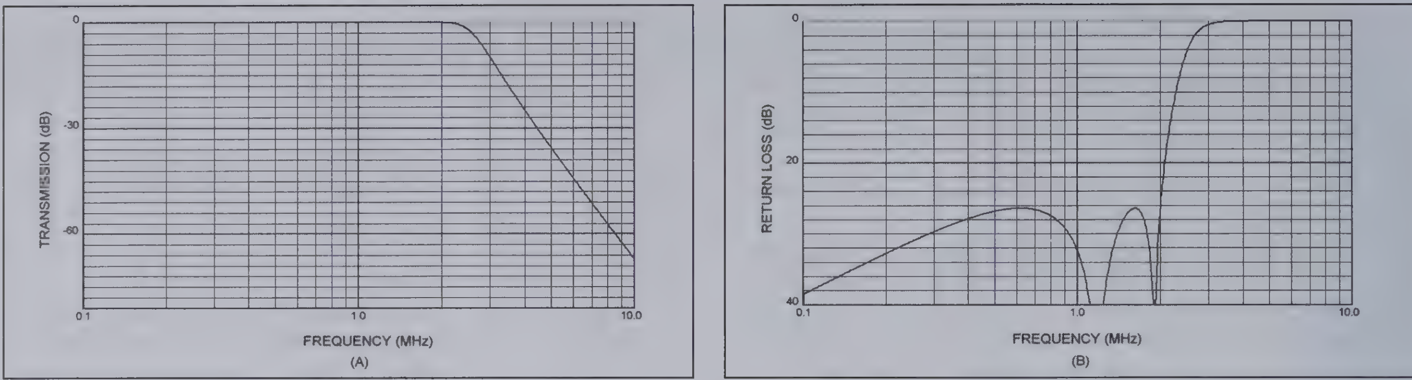


Figure 3—Frequency reponse (A) and return loss (B) for a 5th order, 0.01 dB Chebyshev low-pass filter for the 160M band.

in level with frequency and it would be better to have more attenuation at the lower harmonics. Nature is not working with us here, unfortunately. The return loss plot in Figure 3(B) shows that the reflected signal is well down on the input signal at certain frequencies in the pass band, but peaks at other frequencies. These peaks are where the return loss is lowest and the VSWR the highest. They correspond to 26.38 dB down for the reflected signal, which is a VSWR of 1.1:1. Ideally, of course, you'd want the reflected signal to be so far down it's off the bottom of the graph, but the Butterworth design that produces this sort of return loss performance has poor harmonic attenuation compared with Chebyshev designs and we generally don't use it.

Maximum Usable and Cut-Off Frequencies

The –3 dB cut-off frequency is normally where the pass band is considered to end and the stop band begins. The VSWR is becoming quite high by the cut-off frequency, and for transmitter harmonic filtering purposes a more useful frequency to know is the maximum usable frequency. This is the point in the pass band where the VSWR is about to change from just acceptable to unacceptable. Unfortunately, most design procedures are based on the cut-off frequency, so we're stuck with using that. The relationship between the maximum usable frequency and the cut-off frequency depends upon the order of the filter and the pass-band ripple. The ratio of these two frequencies varies with the order and the type of response. The ratio decreases as the order increases, so the upper band edge can be positioned nearer to the cut-off frequency in 7th-order filters than it can in 5th-order filters. The maximum usable frequency also depends on the minimum allowable return loss, so if this is set too high the upper band edge ends up further away from the cut-off frequency. The maximum usable frequency for the filter response shown in Figure 3 is 2.000 MHz, which is 0.7746 of the cut-off frequency. You'll notice that the return loss drops rapidly above 2.000 MHz and the curve shoots upwards in Figure 3(B). The return loss at 2.000MHz is 26.4 dB and it drops to just over 6 dB at the cut-off frequency. The ratio of these frequencies is a critical parameter in filter design and the maximum usable frequency is usually made 1.02 to 1.04 times the frequency of the upper band edge to allow for component tolerances. Then, if the cut-off frequency turns out to be slightly lower than calculated because all the components are higher than their design values, the return loss at the band edge will still be acceptable. The design used to produce the plots in Figure 3 didn't have a tolerance margin, and that's why 2.000 MHz is the maximum usable frequency for a return loss of 26.4 dB down (VSWR = 1.1). In practice, it would be higher by some small margin as just mentioned.

Unconventional Designs

There are both modified and low-ripple Chebyshev designs around that use SVCs, but what is really required is a totally flexible design that doesn't make any compromises, or very limited compromises, to accommodate SVCs. There is such a design, and it's been around for some years. It has not been well publicized though. It makes use of the fact that low-pass filters for attenuating transmitter harmonics don't have to provide a good match below about 0.66 of the cut-off frequency. If you think about it, a fundamental signal at half the cut-off frequency would only have 3 dB attenuation at its second harmonic. Generally, we only use the part of the pass band between about 0.66 and 0.85 of the cut-off frequency. So, designs for filtering transmitter harmonics don't have to have equal ripple throughout the pass band, and the match down in the lower part of the pass band can be sacrificed in order to improve the match in the upper part and the level of attenuation in the stop band. These unequal-ripple low-pass designs are called "Acromorphic" filters and a version with an added zero, an "AWAZ" design, is even more flexible than the standard Acromorphic design. It can provide a stop-band performance that is comparable with a Cauer design without the inconvenience of the awkward capacitor values the Cauer design generally requires. Both standard Acromorphic and AWAZ designs are specified by the ripple in their lower valley (LVR) where it is deepest. Standard Acromorphic low-pass filter design has been described already in a couple of *QEX* articles [1, 2] and the information provided shows how flexible unequal-ripple designs can be. The AWAZ filter design has the added advantage that it can be tailored to provide almost equal attenuation at the second and third harmonics. The circuit of the pi-configuration 5th-order AWAZ design is shown in Figure 4. Table 2 shows the component values for the various HF amateur bands for this design. Table 3 provides them for the T-configuration low-pass filter circuit shown in Figure 5. Note that a range of capacitor values can be used for any given amateur band and all that changes is the LVR. All of these AWAZ low-pass filters have been designed to

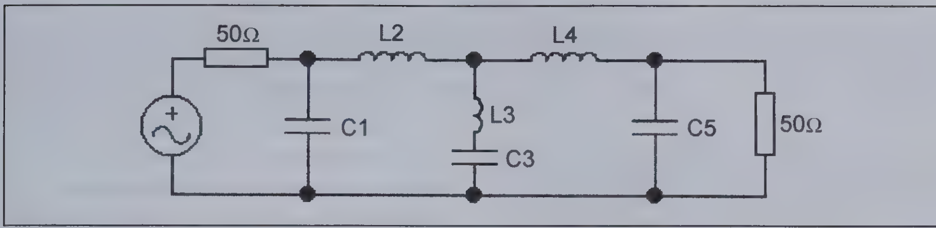


Figure 4—5th order AWAZ filter design, pi-configuration.

BAND	LVR	C1	L2	C3	L3	L4	C5	Remarks
160m	0.82 dB	2200 pF	3.360 uH	3300 pF	0.526 uH	3.360 uH	2200 pF	
160m		2000 pF		3000 pF			2000 pF	
160m	0.37 dB	1800 pF	3.750 uH	2700 pF	0.610 uH	3.750 uH	1800 pF	
160m	0.12 dB	1500 pF	4.100 uH	2200 pF	0.818 uH	4.100 uH	1500 pF	CW only
75m	1.02 dB	1200 pF	1.650 uH	1800 pF	0.265 uH	1.650 uH	1200 pF	
75/80m	0.55 dB	1000 pF	1.810 uH	1500 pF	0.275 uH	1.810 uH	1000 pF	
75/80m	0.33 dB	910 pF	1.900 uH	1300 pF	0.350 uH	1.900 uH	910 pF	
75/80m	0.22 dB	820 pF	1.950 uH	1200 pF	0.360 uH	1.950 uH	820 pF	
40m	0.71 dB	560 pF	0.900 uH	820 pF	152 nH	0.900 uH	560 pF	
40m	0.44 dB	510 pF	0.988 uH	750 pF	166 nH	0.988 uH	510 pF	
40m	0.24 dB	470 pF	1.080 uH	680 pF	187 nH	1.080 uH	470 pF	
30m	0.77 dB	390 pF	0.600 uH	560 pF	110 nH	0.600 uH	390pF	
30m	0.49 dB	360 pF	0.660 uH	510 pF	121 nH	0.660 uH	360pF	
30m	0.28 dB	330 pF	0.720 uH	470 pF	131 nH	0.720 uH	330pF	
20m	1.02 dB	300 pF	0.400 uH	430 pF	73.5 nH	0.400 uH	300pF	
20m	0.53 dB	270 pF	0.485 uH	390 pF	81 nH	0.485 uH	270pF	
20m	0.35 dB	240 pF	0.510 uH	360 pF	88 nH	0.510 uH	240pF	
17m	0.53 dB	220 pF	0.400 uH	330 pF	58.6 nH	0.400 uH	220pF	
15/17m	0.66 dB	200 pF	0.335 uH	300 pF	47 nH	0.335 uH	200pF	
15m	0.45 dB	180 pF	0.350 uH	270 pF	53 nH	0.350 uH	180pF	
10/12m	0.32 dB	120 pF	0.260 uH	180 pF	43 nH	0.260 uH	120pF	
10/12m	0.47 dB	130 pF	0.252 uH	200 pF	34 nH	0.252 uH	130pF	
10m	0.85 dB	150 pF	0.220 uH	220 pF	38 nH	0.220 uH	150pF	Not for 12m

Table 2—Component values for pi-configuration 5th-oreder AWAZ low-pass filters.

have a return loss of 26.38 dB or better, and L3/C3 are tuned to the second harmonic in all cases. Because of the notch at 2F, the actual increase in harmonic attenuation with increasing values of LVR is not as great as for the straight Acromorphic low-pass design. AWAZ filters can be designed to have the notch tuned to any harmonic, but generally it's most useful to make it the second.

Just to show you how well these filters perform, the amplitude response and return loss plots for one of the 160-meter designs (LVR = 0.39 dB in Table 3) are presented in Figure 6, parts (A) and (B). The notch produced by L3/C3 in the stop band at the second harmonic is very evident in (A). The attenuation at the second harmonic of the band edges and that at the third harmonic, just a bit higher in frequency than the bounce-back peak, are similar at about 45 dB. The second-harmonic attenuation in the middle of the notch, of course, is much greater. More attenuation can be achieved for the second and third harmonics on bands where the relative width is smaller than it is on the 160-meter band. The return loss peak in the upper pass band of Figure 6(B) is 26.5 dB down, and the response at this level goes from 1.6 MHz to 2.092 MHz. This leaves ample margin for component tolerances and trying to place it nearer to 2.08 MHz at the upper edge gains little because of the dominant effect of the notch at 2F. You'll note that because of the lower valley ripple (LVR) the return loss plot looks similar to that of a band-pass filter, but the Acromorphic low-pass design makes better use of its few components. In order to achieve the same stop-band performance, a band-pass filter would need more components than an Acromorphic low-pass filter.

Conclusions and Final Remarks

Chebyshev equal-ripple designs can be tailored to provide simple SVC low-pass filters, and modifications can be made to improve their second harmonic attenuation, but when all is said and done it's hard to beat a design that starts from scratch and is specifically designed to provide the best possible performance for a particular application using the minimum of components. The Acromorphic low-pass filter is such a design, aimed specifically at transmitter harmonic filtering applications. It's no good if you want a filter with a flat pass band all the way down to DC, but it wasn't designed for that. It's hard to conceive of any design that will beat it for its particular application, but amateurs are an ingenious lot and possibly someone will come up with an alternative in due course. It'll be interesting to see what that is!

In the meantime, you can use the Acromorphic designs presented here and in *QEX* to give you high performance low-pass filters with convenient capacitor values. The designs presented in Tables 2 and 3 are not the only solutions for any given band, and if you have non-standard capacitor values in between those given you can always use them instead. The new design should only need the inductor values to be tweaked to get satisfactory return loss performance across the whole band with adequate tolerance margins. If you'd prefer to use two parallel capacitors for C3, because you've got some that are pretty close, that's a possibility as well. These designs are very flexible, so if they're not quite what you want you can always try changing them to see if you can find a better solution to fit what you've got. The AADE software is a great help in this respect, and will indicate whether you've got a good design before you go to all the trouble of building it. Set L3 so that it resonates with C3 at the second harmonic and then tweak L2 and L4 (or L1 and L5 for the T-configuration version), keeping them both the same value, until you get an acceptable return loss plot. You'll soon find out if it the values you've used are not suitable because the best return loss plot you can get won't quite coincide with the amateur band you want.

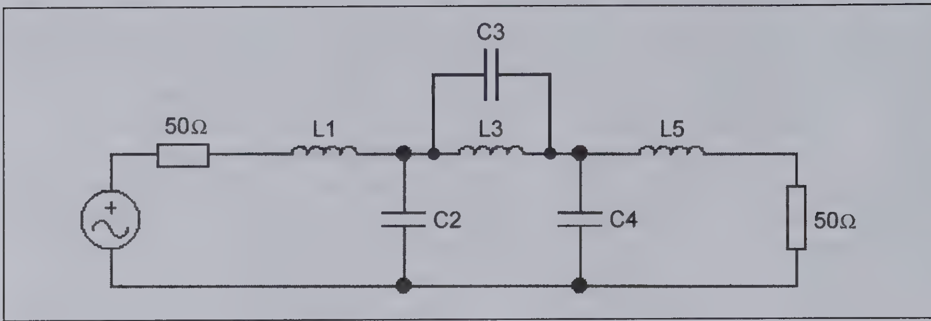


Figure 5—5th order AWAZ filter design, T-configuation.

Band	LVR	L1	C2	L3	C3	C4	L5	Remarks
160m	0.18 dB	4.073 uH	1600 pF	5.864 uH	300 pF	1600 pF	4.073 uH	
160m	0.39 dB	4.772 uH	1500 pF	6.742 uH	270 pF	1500 pF	4.772 uH	
160m	0.89 dB	5.600 uH	1300 pF	8.197 uH	220 pF	1300 pF	5.600 uH	
75/80m	0.16 dB	2.050 uH	820 pF	2.900 uH	160 pF	820 pF	2.050 uH	
75/80m	0.42 dB	2.420 uH	750 pF	3.480 uH	130 pF	750 pF	2.520 uH	
75/80m	0.76 dB	2.760 uH	680 pF	3.950 uH	120 pF	680 pF	2.760 uH	
40m	0.14 dB	1.112 uH	470 pF	1.652 uH	75 pF	470 pF	1.112 uH	
40m	0.22 dB	1.135 uH	430 pF	1.652 uH	75 pF	430 pF	1.135 uH	
40m	0.44 dB	1.285 uH	390 pF	1.829 uH	68 pF	390 pF	1.285 uH	
40m	0.67 dB	1.370 uH	360 pF	1.998 uH	62 pF	360 pF	1.370 uH	
40m	1.01 dB	1.520 uH	330 pF	2.224 uH	56 pF	330 pF	1.520 uH	
30m	0.34 dB	0.885 uH	300 pF	1.314 uH	47 pF	300 pF	0.885 uH	
30m	0.75 dB	1.050 uH	270 pF	1.589 uH	39 pF	270 pF	1.050 uH	
30m	1.09 dB	1.110 uH	240 pF	1.716 uH	36 pF	240 pF	1.110 uH	
20m	0.33 dB	0.640 uH	220 pF	0.955 uH	33 pF	220 pF	0.640 uH	
20m	0.58 dB	0.711 uH	200 pF	1.054 uH	30 pF	200 pF	0.711 uH	
17/15m	0.26 dB	0.422 uH	150 pF	0.593 uH	27 pF	150 pF	0.422 uH	15 & 17m
15m	0.50 dB	0.442 uH	130 pF	0.640 uH	22 pF	130 pF	0.442 uH	15m only
15m	0.91 dB	0.510 uH	120 pF	0.781 uH	18 pF	120 pF	0.510 uH	15m only
10/12m	0.32 dB	0.297 uH	100 pF	0.424 uH	18 pF	100 pF	0.297 uH	Both 10 & 12m
10m	0.58 dB	0.325 uH	91 pF	0.476 uH	16 pF	91pF	0.325 uH	10m only
10m	0.67 dB	0.345 uH	91 pF	0.508 uH	15 pF	91 pF	0.345 uH	10m only

Table 3—T-configuration 5th-order AWAZ low-pass filter component values.

Relying on winding details to get the inductance of a coil close to the desired value can be a matter of luck. The permeability and dimensions of iron-dust cores can vary enough to give considerable variation in the inductance of a toroidal inductor, and squeezing or bunching up the winding can easily give another ±5%. As I've pointed out before, the pass-band ripple and return loss are most sensitive to small component variations, and setting up a filter by measuring the VSWR at the input can be a very good way of getting the component values close or spot on. If your low-pass filter is not on a separate board, this can be done by bread-boarding it on an up-turned piece of PCB and using another fully filtered transmitter as a drive source. Providing the lead lengths are already cropped for soldering them on the PCB, the parasitic capacitance and inductance differences between the two arrangements should be small. Bear in mind that many SWR bridges don't indicate well below about 1.2:1 because of the detector diode knee voltage, and a VSWR of 1.1:1 on most bridges will show as a perfect match. This is particularly true when they're used at low power levels. AWAZ filters need L3 to be set up on the second harmonic anyway, so doing this first and then tweaking the other inductors for best VSWR afterwards should not be too much of an inconvenience. The value of L3 can be set up using a receiver tuned to the second harmonic and connected to a 60 dB attenuator in place of the 50-ohm load. If the filter is fed by another QRP transmitter on the second harmonic, L3 can be tweaked to minimise the S-meter reading on the receiver. Good screening around the receiver, attenuator and transmitter is required for this procedure to work well. It often helps to have the attenuator close to the filter with a longish run of good quality coaxial cable to the receiver. The alternative is to measure the value of L3 accurately beforehand on an LC meter, but this doesn't take in to account any variations in the value of C3, whereas the other method does.

The design values given in Tables 2 and 3 are for use over the whole of each amateur band, but if you're only intending to use the filters over a very restricted part of the band you might want to consider setting up the notch at a frequency other than the geometric mean of the band edges, or even leave it to fall wherever L3 and C3 come out without adjustment. The main thing is to make sure the PA sees a good VSWR at the input of the filter on the frequency youre using in order to give it an easy time. If you do this, the stop-band attenuation will usually pretty much take care of itself.

The improved second harmonic attenuation of 5th-order AWAZ filters will make them a good alternative to 7th-order 0.01 dB-ripple Chebyshev designs, and the better choice will depend largely on the relative levels of the second and third harmonics being put out by the PA. Should more attenuation be required, there is also an AWAZ version of the 7th-order Acromorphic low-pass filter. This is described in the January/February 2011 issue of *QEX*, and anyone wanting to try their hand at designing their own should read this article first. Hopefully, I'll get around to publishing the details of a range of 7th-order AWAZ amateur band low-pass filters in *QQ* in the not too distant future.

Have a Happy and Healthy New Year!

—Dave, G3UUR

References

1. Dave Gordon-Smith, G3UUR, "Fifth-order Unequal-Ripple Low-Pass Filter Design," *QEX*, November/December 2010, pp 42-47.

2. Dave Gordon-Smith, G3UUR, "Seventh-Order Unequal-Ripple Low-Pass Filter Design," *QEX*, November/December 2006, pp 31-34.

The SESE80 80 Meter Receiver

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The SESE80 is a simple easy to build 80 meter superhet receiver. Eight 2N3904 transistors, one LM386 audio IC, and five microprocessor crystals are used along with three 10.7 MHz IF transformers. Tuning is accomplished with a 1N4001 diode. For the builders convenience a printed circuit board is available from Far Circuits, but the circuit can be built manhattan style or dead bug style at the builders' option. The SESE80 was designed to showcase the singly balanced mixer as an alternative to the NE602. Cost of the board mounted parts exclusive of the pc board is about $12.00. Three pots, antenna connector, power connector, speakerjack and cabinet complete the receiver.

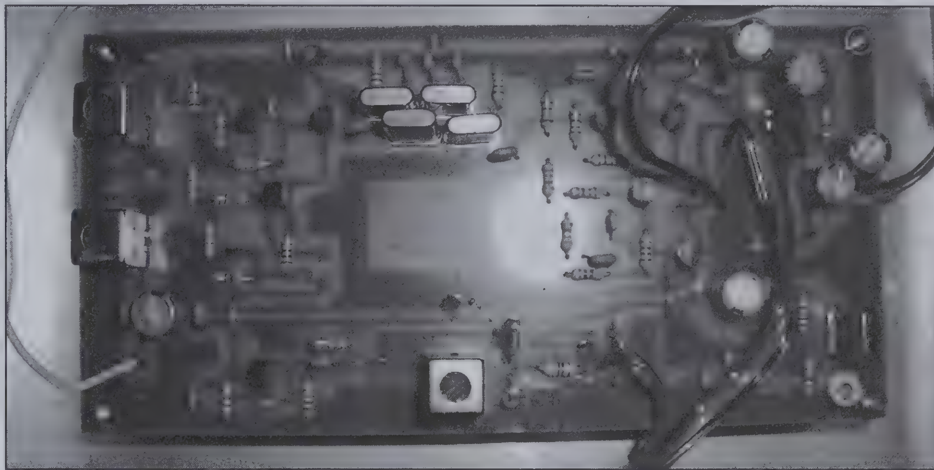
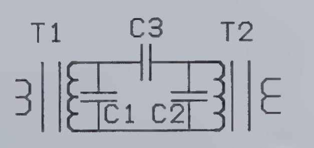


Figure 1—Inside the SESE80 80M receiver p.c. board.

My interest in the singly balanced mixer came from reading the web site of VK3AGJ describing his BC547 QRP SSB Transceiver. Just Google BC547QRPSSB and it should take you to his site. Another application of the singly balanced mixer is the "Direct conversion receiver using a discrete component product detector," page 1.13, *Experimental Methods in RF Design*. After building an abbreviated version of the direct conversion receiver I liked it so well I upgraded it to a superhet. The original prototype was built on a copper clad board dead bug style with the same architecture of the BC547 QRP SSB transceiver except with 2N3904 transistors. I built and tested the circuitry for a transceiver but I decided the transceiver market is pretty well covered so I trimmed it down to receive only. I often see posts on the QRP forums like BITX and MMR 40 from builders who want just a receiver. There are quite a few designs for direct conversion receivers, dating back to the Neophyte by John Dillon WA3RNC in Jan 1988 *QST*, but few superhets. For just a few dollars more, you can build a single conversion superhet and have the advantages of a crystal filter(single signal reception) and more audio that a direct conversion receiver offers. I believe the SESE80 will make a good companion for the Tuna Tin II and such. It is suitable as a first time project, with some help with soldering and component recognition. Advanced builders may find it useful as a platform to test out filters, audio amps, VFOs and such.

Building Blocks—
1. Bandpass Filter

The band pass filter is a modification of the filter described by Chip Owens in Oct. 1990 *QRP Quarterly*. I made it link coupled and used the Mouser 42IF123RC if transformer in place of the TOKO TK1203 coil described in the original article. To couple to the mixer, I tried the link, high side of primary, and the low impedance tap on the primary of T2. I found the latter to be the best match for the first mixer. I know some builders will want to try putting this receiver on other bands, so I show component values for 80, 40, 30 and 20 meters in Fig. 2. I have used these values in other projects over the years. The Mouser IF transformers have an inductance range of 3 to 5.8 uH, nominal is 4.7 uH. The internal cap is 47 pF, I recommend removing the internal cap before installing so the transformer can be used on any band without considering the cap. The cap is easily removed by crushing it with a jeweler's screwdriver. Be sure to check the continuity of the windings before installing. The data sheet for these coils is available for download on Mouser's site.



T1,T2 MOUSER 42IF123-RC
10.7MHZ WITH
INTERNAL CAP REMOVED

BAND	C1,C2	C3
80M	390PF	33PF
40M	100PF	3.3PF
30M	47PF	1.5PF
20M	27PF	1.0PF

Figure 2—The bandpass filter.

2. Singly Balanced Mixer

The NE602 (and other ICs) using the doubly balanced mixer, Gilbert cell, have been the mainstays of QRP designs for over 20 years. Given the volatile nature of the IC market I am surprised the NE602 is still available. Though it lacks the port to port isolation of the doubly balanced mixer a singly balanced mixer performs well in this application, and it is very inexpensive when built with discrete components. Fig. 3A shows the basic differential amp/mixer. Fig. 3B shows the mixer with balanced input and output. Fig. 3C shows the mixers with single ended input and output as I used it. My first two breadboard prototypes were built with a balanced output to the filter via a trifilar wound torroid transformer. Changing to a single ended output caused a loss of gain but this was easily made up in the audio amp with an increase in the feedback cap. Scratch builders might want to try it both ways. Note the RF and IF ports are interchangeable, this may give some flexibility in layout .

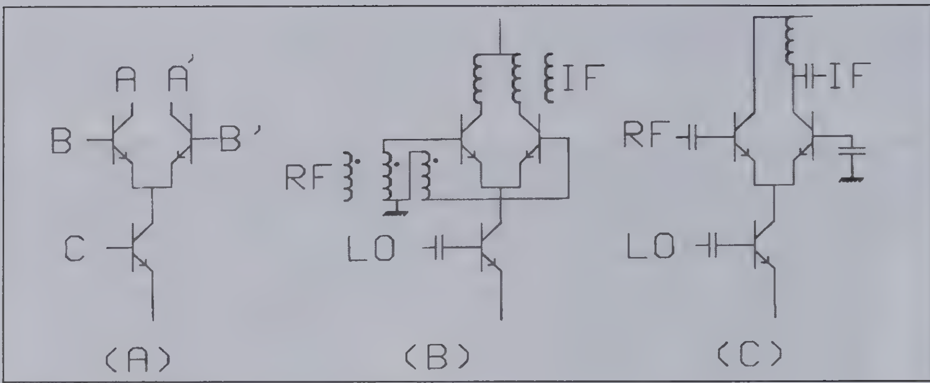


Figure 3—The singly-balanced mixer.

3. Filter

The XTAL filter was designed using the filter program downloaded from AADE site, www.aade.com. In the initial prototypes I tried 5 MHz, 6 MHz and 11 MHz XTALs before deciding on the 10.0 MHz. I wanted to use the 11.0 MHz but ran into image problems. With no filter on the VFO the 7.0 MHz second harmonic, 14 MHz beats with an 11 MHz IF and the 3.0 MHz image is within the band pass of the front end, and some images like CHU popped up. I used the default values for 10 MHz xtals in the AADE program for the final values. Without the 330 ohm resistors there was a pronounced dip in the middle of the pass band. One unusual feature of the filter is that it is returned to the B+ buss rather than ground. This was done as a matter of convenience in the original PC board layout that had two filters, one in series and one in shunt configuration. I later discarded the shunt configuration. The B+ bus s serves as well as ground since the buss is well bypassed to ground.

WINSCOPE, a free download program (Goggle WINSCOPE) with an audio spectrum analyzer built in is an excellent way to evaluate the filter. Simply feed noise into the receiver (from antenna or noise bridge), connect the audio from the SESE80 to the computer sound card, set WINSCOPE to storage mode in the spectrum analyzer function and it will paint a silhouette of the band pass response. Scale left to right is 0-5000 Hz, remember this is Lower Side Band, left to right is descending in frequency and the amplitude is in volts not dB. Check your Ricebox with this method.

4. BFO

The BFO is a simple Colpitts circuit. Best performance of the receiver requires the BFO to be set to the correct frequency with respect to the filter bandpass response curve. Winscope is an excellent way to do this. The left hand slope of the curve should be between 300 and 500 Hz of the carrier frequency. Another test is to tune down on a steady carrier. As the frequency is lowered the signal will come into the bandpass, rise to a peak, fall off and dissapear near zero beat. Adjust trimmer to set BFO frequency.

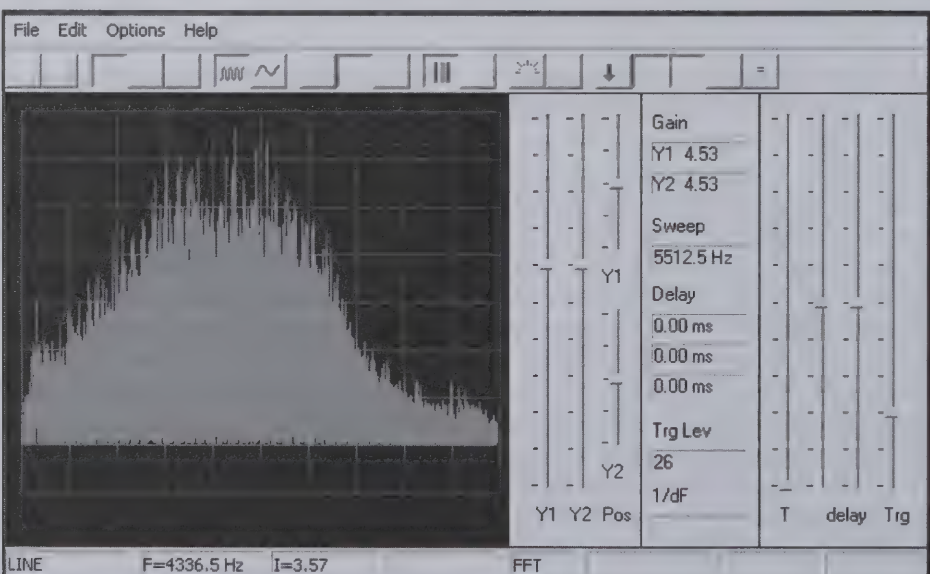


Figure 4—WINSCOPE PC screen and display.

5. VFO

ARRL guidelines state a VFO should be capable of stability in the order of 100 Hz over a ten minute period. This is reasonable as you can listen to a SSB QSO with out retuning until the shift is 100 to 200 Hz. Stability of 115 Hz per ten minutes was achived in the SESE 80 VFO.

My original choice for tuning was the polyvaricon capacitor. Problems with mounting the polyvaricon to a reduction drive lead to a change to varactor tuning. I tried LEDs and diodes and settled on the 1N4001 diode. Best data I had from the internet indicated a change of only 10 pF from 0 to 9 volts so I tried 3 then 4 diodes in parallel. Drift was terrible, about 400 Hz per minute. Cause of the drift was determined to be the 100k resistor. With four diodes in parallel I had about 4 volts drop across the 100k resistor. Changing to a 470 uH RF choke solved the drift and the voltage drop so I could get 500 kHz coverage in the VFO with only 5 volts swing and a single diode. A further reduction in drift was accomplished by changing the bias values. Toroid cores, T50-2 and T50-7, in place of the Mouser 10.7 if coil were tested, but no advantage was found so the 10.7 ift was retained. I encourage the builder to use multi-layer ceramic COG (NP0) caps in the VFO. My experience of late with disc ceramic types has been poor. Note there are three unused holes to the left of the VFO coil. I put these in the PC board layout in case the builder wants to pad the VFO down to another frequency.

Running stability trials is like watching paint dry. I used a program called ARGO to record the drift. Argo will be familiar to those who have copied beacons running qrss, very slow speed CW. In the wide band mode a waterfall display of 0-1500 hz is presented. Time span top to bottom is only 30 seconds but Argo has a capture feature that allows you to save a screen at any time you specify. I set the capture to record every two minutes then overlapped the printouts as shown in Fig 6. You just

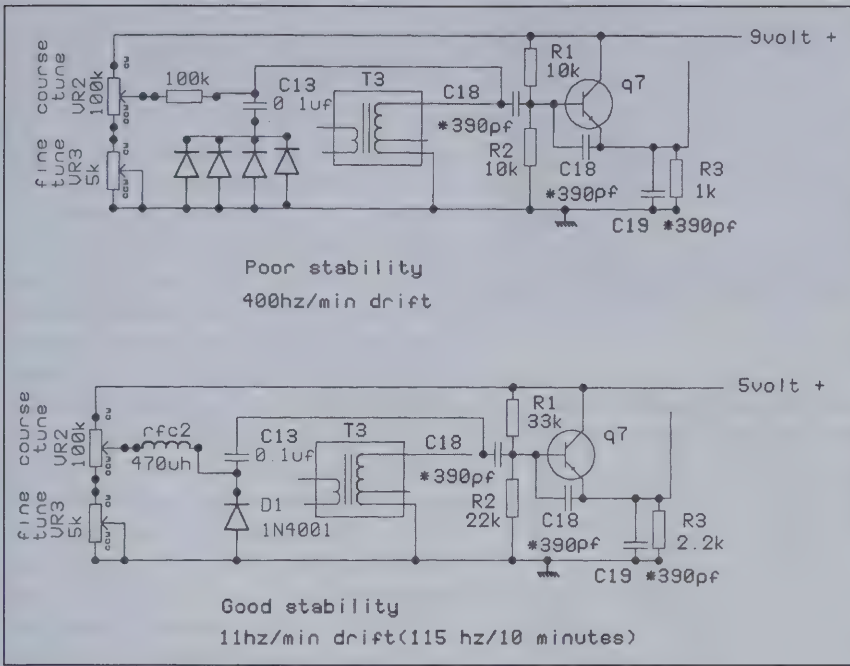


Figure 5—VFO development: first try (top) and final design (bottom).

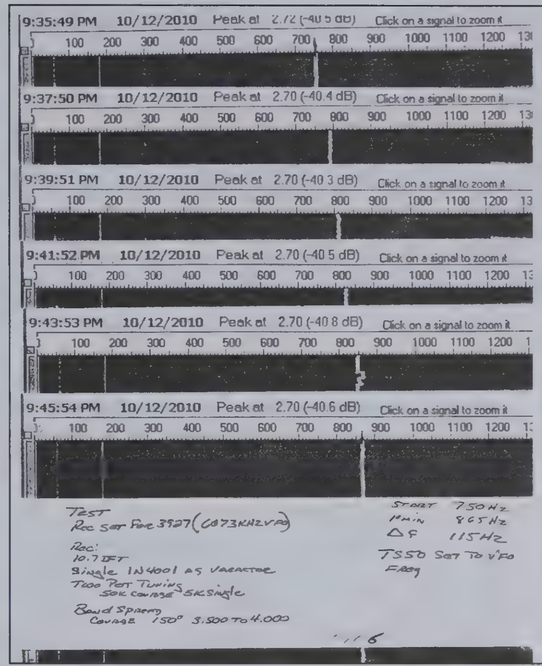


Figure 6—VFO stability test results with ARGO.

set the general coverage receiver about 1 kHz away from the VFO frequency start ARGO, set for capture every two minutes or so, and go do something else while it runs. Argo may be downloaded from www.weaksignals.com .

6. Audio

I used the LM386 for audio. This is a pretty standard circuit. Audio may be a little hot with the 10 uF cap between pins 1 and 8, this sets the gain. If there is any distortion at full volume you may lower the value of C31 from 10 uF to 4.7 uF or less. In the pictures I used flat ribbon cable for the connection to the volume control, I don't recommend this use two wire shielded cable to avoid any hum pickup.

Construction and Alignment.

First step in assembly is to remove the internal caps from the IF transformers. Be sure and check the continuity of the winding before installing. Proceed with the installation of the parts on the board. When completed install the board in a metal case and connect the power, speaker, antenna, volume and tune controls.

The two pot tuning works well and a 10-turn pot has been tried, too. The nonlinearity of the diode is very noticeable with a ten turn pot for the main tuning, I compensated for the non linearity by using an audio taper pot for the coarse tuning. I found I could compress the 500 kHz span into 180 degrees of rotation by first setting the fine tune to middle of its rotation, then set the coarse tuning pot at the clockwise stop and install the know pointing to

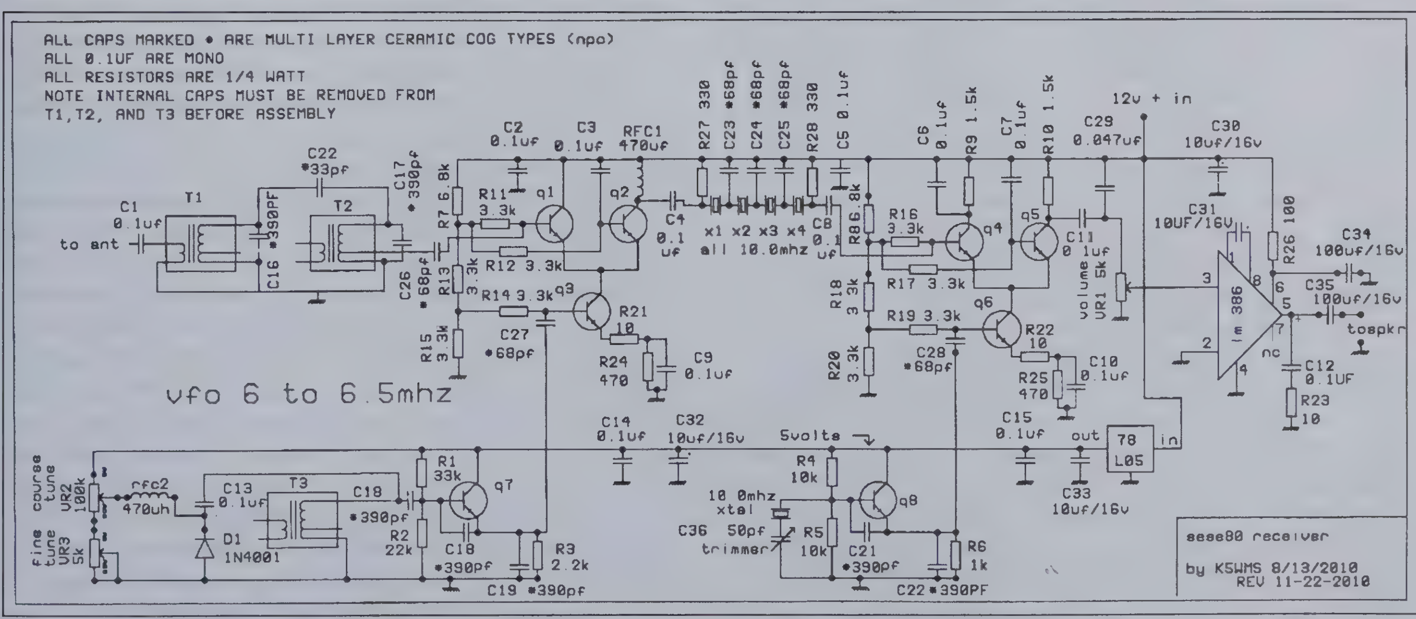


Figure 7—Schematic diagram of the receiver.

Figure 8—Front panel of the SESE80 receiver.

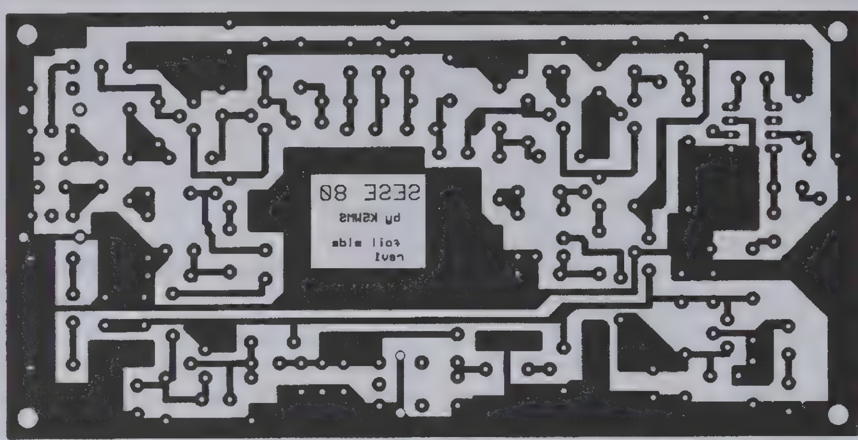


Figure 9—Foil pattern for the p.c. board.

Board Mounted Components:

ITEM	DESCRIPTION	SOURCE	PART NUMBER	NO. REQ'D
T1,T2,T3	10.7 MHZ IFT	MOUSER	452IF123-RC	3
Q1-Q8	2N3904	MOUSER	610-3904	8
U1	78L05	MOUSER	511L05ACZ	1
U2	LM386			1
X1-5	10 MHZ XTAL	MOUSER	559-FOX100-20-LF	5
C1-15	0.1 UF MONO CAP	MOUSER	581-SR215E104MAA	15
C16-21	390 PF MLC COG	DIGIKEY	BC1020-ND	6
C22	33 PF MLC COG	DIGIKEY	BC1007CT-ND	1
C23-28	68 PF MLC COG	DIGIKEY	BC1011CT-ND	6
C29	0.047 DISC CER	MOUSER	140-US-472M-RC	1
C30-C33	10 UF/16V	MOUSER	647-USW-121C100MDD	4
C34-35	100 UF/25VOLT	MOUSER	647UV21E101MUTA	2
C36	50 PF TRIMMER	MOUSER	659GKG50015	1
D1	IN4001	MOUSER	512-1N4001	1
R1	33K ¼ W			1
R2	22K 1/4W			1
R3	2200 1/4W			1
R4,5	10K 1/W			2
R6	1000 1/4W			1
R7,8	6800 1/4W			2
R9,10	1500 1/4W			2
R11-20	3300 1/4W			10
R21-23	10 1/4W			3
R24,25	470 1/4W			2
R26	1000 1/4W			1
R27,28	330 1/4W			2
RFC1, 2	470 UH	MOUSER	542-78F471-RC	2

Chassis mounted components:

Audio gain pot	5 or 10 k audio taper			1
Coarse tune pot	100k audio taper	Radio Shack	271-1722	1
Fine tune pot	5k linear taper	Radio Shack	271-1714	1
Power connector	size M jack	Radio Shack	274 1563	1
Speaker jack	1/8 in mono jack	Radio Shack	274-0251	1
Antenna conn.	chassis mount SO239			1

Parts list

5 o'clock. Then turn the knob back to the 3 o'clock position and set the VFO coil (T3) for a VFO frequency of 6.5 MHz, or a receive frequency of 3.500 MHz. Rotate the course control back to 9 o'clock and the VFO should be at 6.0 MHz or a receive frequency of 4.0 MHz. The 100 kHz marks can then be added to the panel. Note this works with the Radio Shack 100k audio taper pot but may differ with other manufacturers as the taper may be different. The fine tuning pot has more effect in the higher portion of the tuning range. Compressing the tuning range into a 180 degree arc allows the use of a plastic vernier drived with stops at 0 and 180 degrees. If a reduction drive is used the builder may not want to retain the fine tune pot.

BFO may be set as described in the section above with WINSCOPE or listening to where the received signal drops out at or near zero beat by adjusting the trimmer C36.

Alignment of the front-end bandpass filter is not very critical. It can be set by listening to background noise , set T1 for peak at 3.9 MHz and then set T2 for peak at 3.7 MHz. I also set the front end with a MFJ SWR analyzer by hooking the analyzer to the antenna input and tuning for min SWR at 3.9 MHz. Once when I had T2 too far down (CW direction) I heard some foreign broadcast feed through. This was eliminated by turning the core in T2 ccw a couple of turns and re-peaking T1.

In conclusion I hope you enjoy this project if you decide to build it or use the ideas to build your own design. I am not an engineer just a hobbyist. I have an engineering background but it is in fractional HP electric motors, not radio. I encourage builders to read up on differential amplifiers and the notes on balanced mixers in *EMRFD* and the ARRL handbooks. Printed circuit boards will be available from Far Circuits and Fred Riemers is looking into producing a kit of the circuit boards and the board mounted components. That will be Fred's enterprise and I will have no financial involvement. Keep an eye on Fred's site at www.farcircuits.net for developments. Fred and I are working on an pictorial assembly manual to go with the boards. I will support the builders in any way I can. I may be reached at k5wms@centurytel.net

SimSmith: A New Program for the Venerable Smith Chart

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When I first got started in amateur radio, I was browsing the local bookstore and happened upon Wes Hayward's *Introduction to Radio Frequency Design*. After a quick examination I decided it would be a good primer to the topic, purchased it, and began to work my way through it. Chapter 4 of *IRFD* introduced the Smith chart and I read through the chapter several times. Unfortunately, understanding eluded me for quite some time. Still, I could glimpse its value and remained determined to understand the chart's utility. Finally it clicked and I started to use the Smith chart to solve a variety of problems around the shack. For those of you who remain mystified, I hope to help you along. For those of you who are already comfortable, I hope you'll find this a useful review.

Originally, the Smith chart provided two fundamental functions. The first and most important function was to simplify the calculations involved with the use of transmission lines and lumped, complex impedances. A secondary function was to provide a graphical aid in understanding the effects of combining the various circuit elements.

In the modern age, using the Smith chart to perform calculations has gone the way of the slide rule; such calculations are best done using a computer program. However, the utility of the Smith chart to enhance the understanding of complex impedances has not diminished. Indeed, use of the Smith chart has grown over the decades since its invention. The Smith chart remains one of the most widely used nomographs used in the practice of electrical engineering.

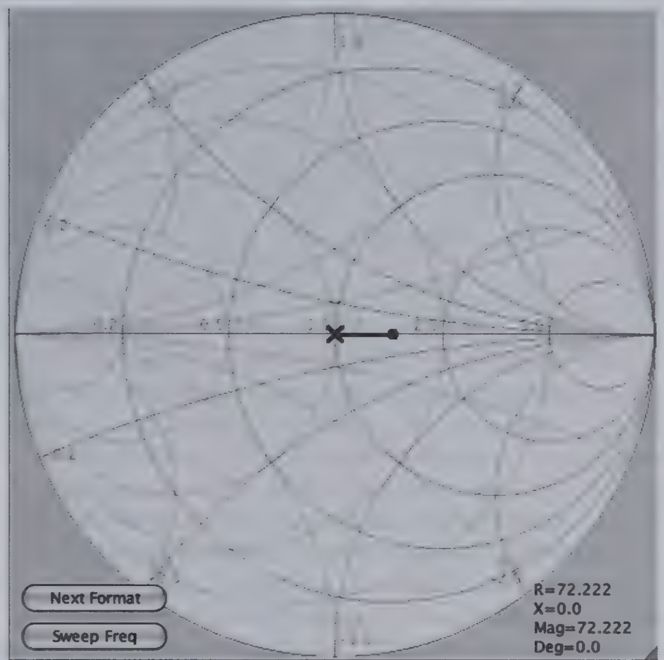


Figure 1—Ideal impedance transformation from 72 ohms to 50 ohms (not practical).

Gettig Started

As mentioned above, the calculations involved with complex impedances are most easily done using a computer but visualization is still the job of graphs and pictures. A variety of computer programs are available which provide schematic capture, calculation and graphing all in a single package. Some of the more popular programs are Microsmith, LinSmith, QuickSmith and SuperSmith. Any of these programs provide the essential features necessary to learn about the use and utility of Smith charts. However, I found some shortcomings in each of these widely available packages. I had always wanted to learn the Java programming language and there is nothing like writing code to force you to understand "every little detail" and so, I wrote my own Smith chart software. The software, along with some instructional videos, is available on my website: www.ae6ty.com/software. I named it SimSmith.

SimSmith was developed with a few guiding principles. There are times when I will go months between uses of a particular tool and I often forget how to do things with it. I wanted to avoid the "relearning curve" and so made the following design choices.

First, I wanted all information about the circuit to be visible all the time. All circuit element values as well as their derivatives. For example, for a transmission line I wanted length and degrees and velocity factor all shown all the time. Second, I wanted there to be ONE window. Switching back and forth between schematic capture and circuit analysis often slows the process. Third, the display should be real time and convey the maximum information. In following these principles, SimSmith requires the user to remember very little. Essentially, everything you might need to know about is always right in front of you.

It is probably best to use a specific and familiar example to get started. Suppose we wish to provide an impedance transform between a 50 ohm transceiver and a 72 ohm dipole. Figure 1 shows the Smith chart for this example. In it, the "dot" represents the starting impedance (the dipole) and the "X" represents the final impedance (the transmitter). NOTE: The Smith chart represents all impedances normalized and in most cases our target impedance will be the "normal" impedance. This means that usually, our goal will be to have the X at the center of the Chart.

Figure 1 shows the 'ideal' situation where the impedance transformation goes directly from 72 ohms to 50 ohms. The transition is shown as a straight line. Unfortunately, this transition requires an unrealizable, negative 22-ohm resistor. In the real world, we will need to use the familiar L network circuit shown in Figure 2.

Figure 2 shows a typical schematic with the *Load* on the left with 72 ohms of *real* and 0 ohms of *reactive* impedance. Moving to the right, Figure 2 shows the classic L network consisting of a shunt capacitor of 146 pF and a series inductor of 535 nH. On the far right is the *Generator* which is shown as operating at 10 MHz with a characteristic impedance of 50 ohms real and 0 ohms reactive. The Smith chart related to this schematic is shown in Figure 3.

One of the most valuable features of modern Smith chart software is to allow the user to vary the values of the various circuit elements and to see, immediately, the effect by viewing the Smith

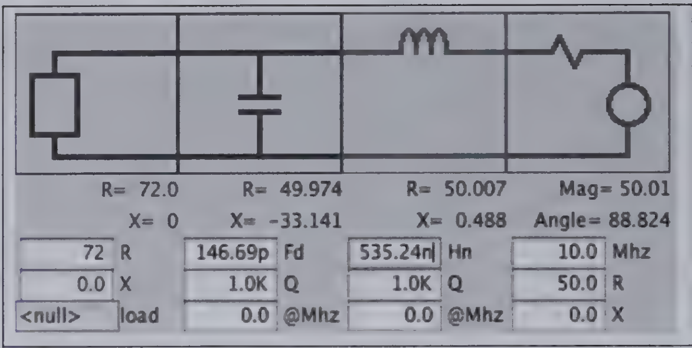


Figure 2—L network in SimSmith.

chart. For example, the user can select a parameter on the schematic and increase or decrease the value and watch the effect of changing that value. This is where the interactive nature of the tools comes into play. Unfortunately, it is very difficult to explain the experience in the written word. I highly recommend the reader go download one of the tools and PLAY! In the meantime, for the purposes of this paper, assume the user selected the inductor value and doubled the value. Figure 4 shows the resulting Smith chart. A significant feature of SimSmith is that it shows the path taken by the X as the various circuit elements are introduced.

Figure 4 shows an entire screen shot of SimSmith. Notice that the X has moved way from the center of the graph. On the lower right hand corner the impedance at X is shown. Specifically, the effect of doubling the L is to introduce an additional reactance of +34 ohms. In general, the goal of any impedance matching exercise is to start at the dot and add circuit components to get the X to move to the center of the Smith chart.

SimSmith

As Figure 4 shows, SimSmith provides a comprehensive set of capabilities. The first step in any use of SimSmith is to specify the Load and the Generator. In the case of the Load, SimSmith allows the user to specify the load in two different ways. The first way is to simply enter the R and X values by clicking on the numbers and typing in a numeric value using a familiar notation. This technique works well when the Load does not vary with frequency. Unfortunately, this is not the case with antennas.

To deal with antennas, the user must be able to specify the load at the various frequencies of interest. SimSmith provides the ability to read a *load file* containing frequency/resistance/reactance triplets. Three common formats are supported, one compatible with EZNEC antenna modeling software, one compatible with the AIM4070 antenna analyzer and one compatible with the MiniVNA-pro. No practical limits are placed on the size of these load files.

The second step in using SimSmith is to specify the operating environment in the Generator box. Specifying the operating environment requires the user to set the operating frequency and default impedance. The vast majority of the time, the operating impedance will be 50 ohms real and 0 ohms reactive. However, the user is allowed to specify any value. The center of any SimSmith Smith chart always represents the R +jX of the Generator.

Schematics are created using an intuitive drag and drop interface. The user can add components by selecting from the menu of

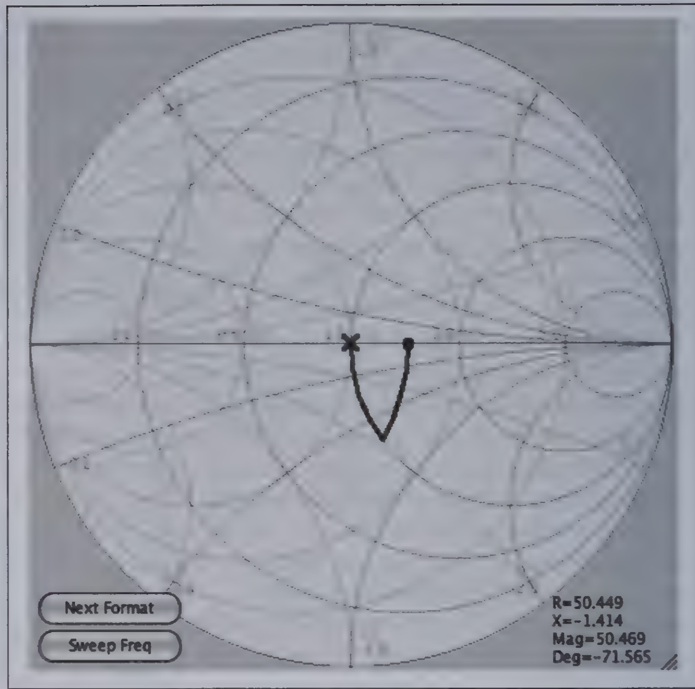


Figure 3—Smith Chart for the L network of Fig. 2.

circuit elements on the left of the screen and simply moving them to the appropriate place in the circuit. Elements within the circuit can also be moved around using the same click/drag/drop interface. Unfortunately, it is difficult to demonstrate this simple interface in a written document. Consequently, the reader is encouraged to download SimSmith and give it a try. (In order to make SimSmith available to the widest possible user base, the author chose to write SimSmith in Java. In order to run a Java program the user must have the Java Runtime Environment or JRE installed. The JRE for windows and various unix derivatives is available, free of charge, from Sun Microsystems at http://www.java.com/en/download/index.jsp. Java for Apple computers is available directly from Apple. Java is often preinstalled on many computers. (As a final note… your browser might alter the download file extension from .jar to.zip. The file extension

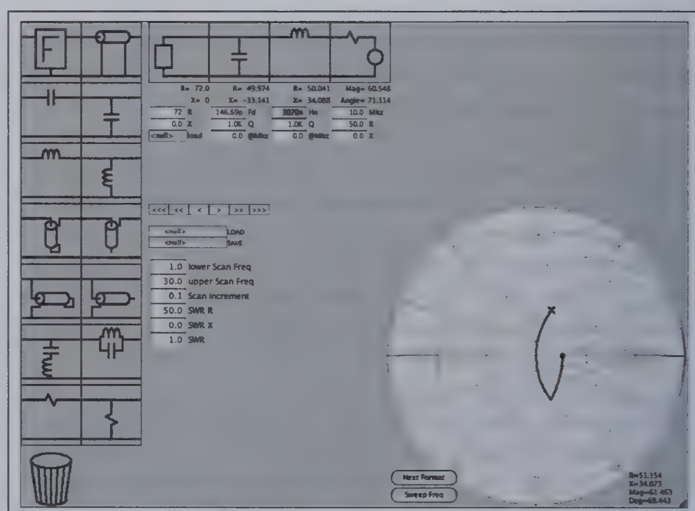


Figure 4—Smith Chart with inductance doubled.

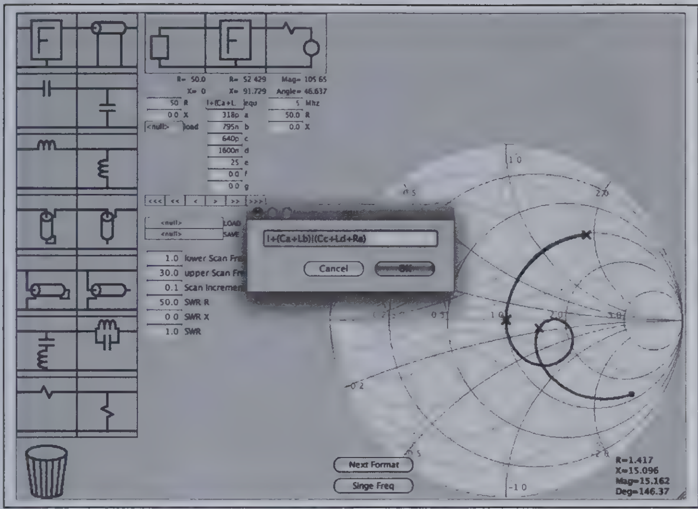


Figure 5—An example use of the F box.

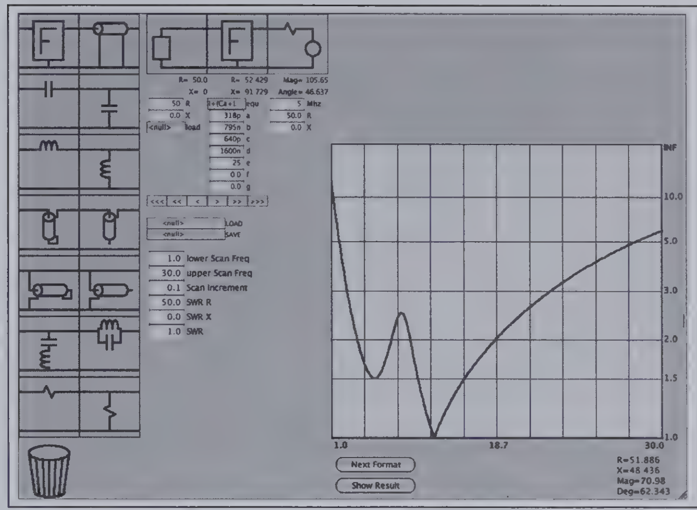


Figure 6—SWR display for an antenna with two traps.

must be changed back to .jar for things to work properly. This problem is not unique to SimSmith.)

In developing SimSmith, I endeavored to provide some unique features sometimes lacking from other Smith chart software. For instance, the project was initially inspired by the need to faithfully model transmission lines; specifically to include the losses. These losses can prove quite significant when transmission lines are used as matching stubs. SimSmith allows the user to specify transmission line loss at a specific frequency. It computes the losses at other frequencies using traditional formulae.

SimSmith allows an operating impedance which can have a reactive component.

SimSmith allows both positive and negative component values. This can help the designer during the exploration phase.

SimSmith has no practical limits on the size of a circuit. As the circuit gets larger, SimSmith simply reduces the size of the components on the screen.

SimSmith scales its display to fit the window. Thus, the user can set the window to be any size and SimSmith can still be used; no information is obscured because the window size has changed. This is particularly valuable when using a large, high resolution monitor.

Finally, there are times when the user wants a circuit element not provided by SimSmith. For example, suppose the user wants to model an antenna that has traps with TWO resonant LC circuits. SimSmith allows for this by providing the "F" box. An example is shown in Figure 5. (Note that the equation for the F circuit element does not fit in the provided space. This is often the case. As a result, SimSmith uses a popup dialog when entering the equation. This capability is shown in Figure 5.) See Appendix A for a complete specification of the F box expression format.

Figure 5 also shows another extremely valuable feature always found in Smith chart software: frequency sweep. SimSmith can show how the circuit will operate over the range of frequencies specified. SimSmith can also plot the data in the more familiar SWR format shown in Figure 6. Notice that the SWR plot in Figure 6 shows two dips, one at 10 MHz (the resonance of Ca + Lb) and one at roughly 5 MHz (resonance of Cc + Ld). The valley at 5 MHz is slightly off because of the resistance Re.

Moving the X

As discussed above, using the Smith chart is essentially an exercise in moving the X to where you want it to be. In practice, there are three different ways to move the X. One can introduce a capacitance which generally moves the X downward. Conversely, one can introduce an inductance which generally moves the X upward. A final X movement is made by using a transmission line. All three movements are shown in Figure 7. Figure 7 starts with a load (the dot) at 25 ohms, adds a shunt capacitor, a series transmission line and a series inductor. The path taken by the X is represented by the three arcs. The X starts at the dot, proceeds along the downward arc, then goes clockwise around the center of the chart to about "3:30" and then traverses the final arc up to the center of the chart.

The example in Figure 7 demonstrates a few subtle features of complex impedances as represented in the Smith chart. First, all movement around the Smith chart takes place along arcs. When adding shunt reactance the arcs will be circular with an origin to the left of the center of the chart. Conversely, when adding series reactance the arcs will be along arcs with origins to the right of center. Series transmission lines result in arcs centered at the line's

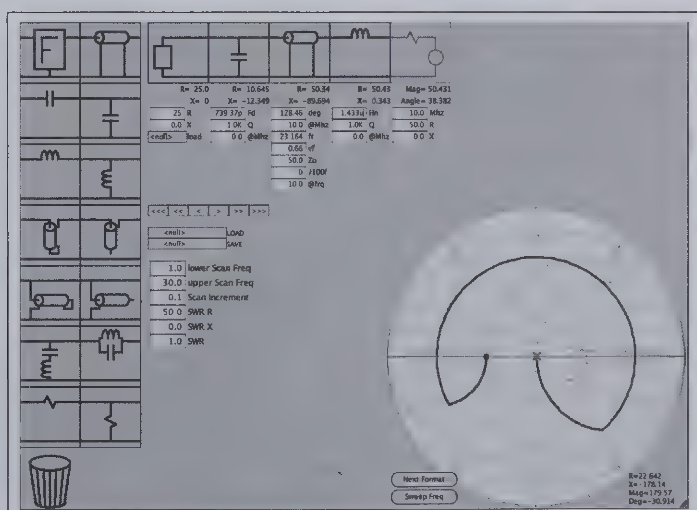


Figure 7—Smith chart for a three element circuit.

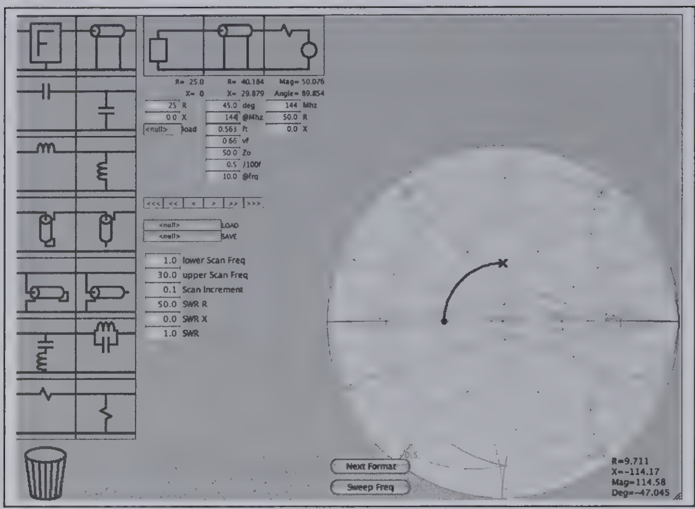


Figure 8—Effect of a 1/8th wave line on 25 ohm load.

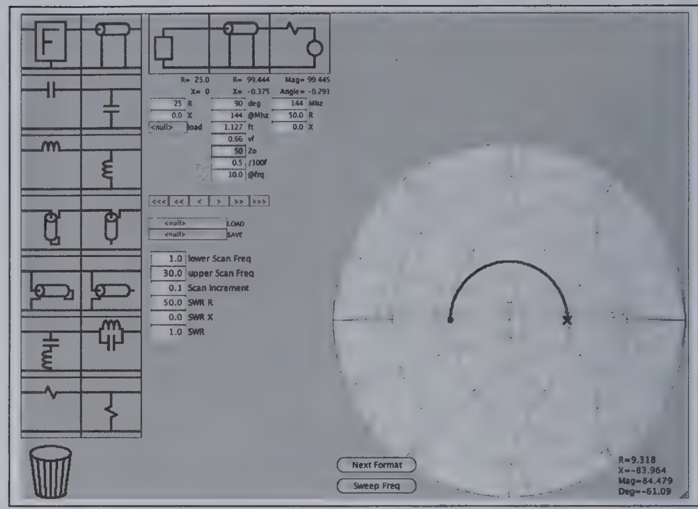


Figure 9—Changing the line to 1/4 wavelength.

characteristic impedance. Typically, this impedance is that of the Generator.

Second, these arcs of movement are so important that they are always shown on the chart. Showing these arcs of movement helps guide the user while a components value is adjusted. Particularly—when attempting to reach the center of the chart, the user typically will move the X to the unit resistance or unit conductance curve, then simply move the X along that curve. This may sound complicated but is quite natural after a short time using the Smith chart.

Third, the Chart is not linear… for simple reactances, doubling the value of a component does not generally result in doubling the distance moved. For example, in Figure 7 the distance from the center of the chart to the starting dot is 25 ohms but is 1/3 of the way from the center out. The shunt reactance is over 5k and yet the distance from the center is only 3 times as far away.

Fourth, for standard Smith charts, the X cannot be moved out of the circle. Thus, the perimeter of the circle represents an infinite reactive impedance. Not clearly shown in Figure 7 is the fact that the extreme left of the Chart represents a real resistance of 0 ohms and the extreme right represents an infinite resistance.

Finally, although not shown, adding resistance moves the X along arcs that go through the leftmost and rightmost points of the Chart. Adding an infinite series resistance results in an arc ending at 3 o'clock. Adding a zero, shunt resistance results in an arc ending at 9 o'clock.

Having mastered these basic movements, a few more examples are in order.

The Quarter Wave Matching Stub

It is often the case that a Yagi-Uda antenna has an impedance significantly lower the typical 50 ohm feed line. A common remedy for this problem is to use a quarter wavelength matching stub. Figure 8 shows how one might get started solving this problem. Figure 8 shows a load of 25 ohms and a generator impedance of 50 ohms and an operating frequency of 144 MHz. Also shown is a 50 ohm, series transmission line which will be tuned to effect the impedance transformation.

The first step in this tuning process is to set the length of the matching transmission line to 90 degrees. This is done by clicking on the *deg* box of the transmission line and setting the value to 90. Figure 9 shows the result of this step. The next step is to adjust the characteristic impedance of the quarter wave section. This can be done in SimSmith by selecting the characteristic impedance box labeled Zo and typing in a value. Alternatively, you can click on the Zo box and then use the tuning buttons "<<< | <<| < | > | >> |>>>". Figure 10 shows the result.

Note that, in the end, the X didn't end up at the exact center. This is because the user (I) chose to make the matching stub 37 ohms. A 37 ohm stub can be constructed by using two sections of 75 ohm transmission line in parallel.

Modeling the Dipole Antenna

Using the Smith chart to examine antenna parameters gives us a hint as to how to model a simple dipole antenna. Figure 11 shows a basic 72 ohm dipole swept across a fairly wide frequency (12 to 17 MHz). In this example, the antenna characteristics were generated by an antenna modeling program (EZNEC) and read into SimSmith. Note the resonant frequency is 14.167 MHz. The goal of this exercise is to see if we can develop a model of

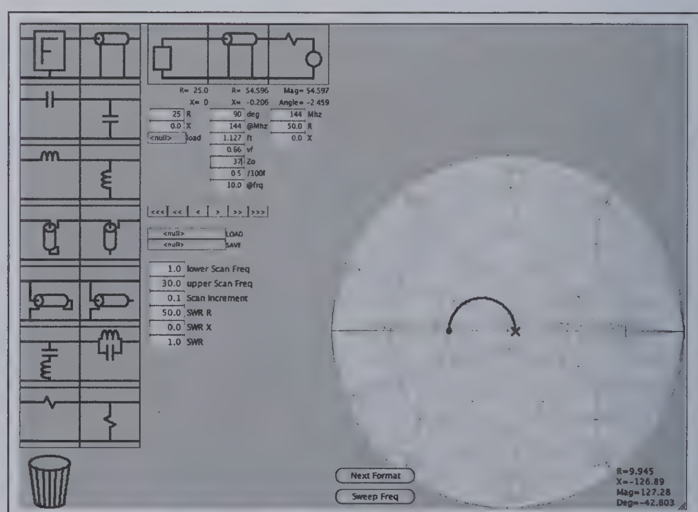


Figure 10—Changing line impedance to 37 ohms.

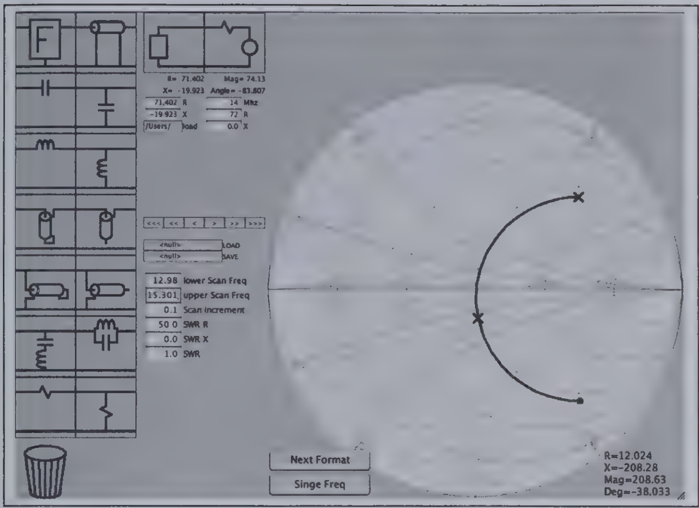


Figure 11—Impedance of an ideal dipole over a wide frequency range.

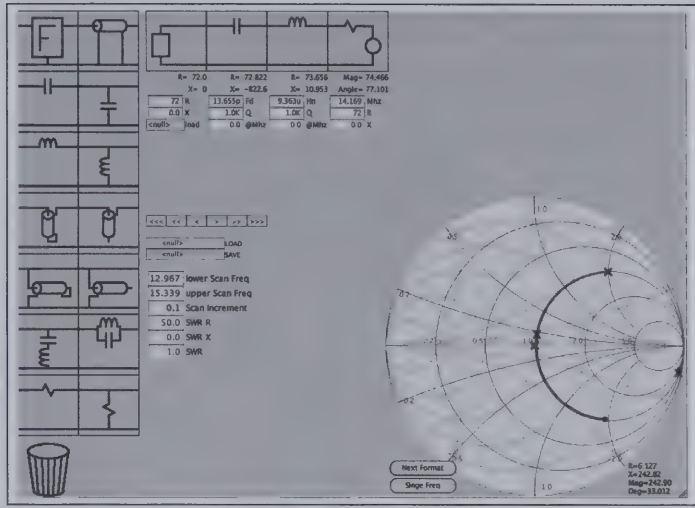


Figure 12—Using LCR elements to make a model equivalent to an ideal dipole.

this simple antenna using the Smith chart. There are several reasons such a model might be useful. For example, one could build a reactive dummy load for amplifier and antenna tuner testing. Or, one could use the model in other simulation to ensure amplifier stability within the band of interest.

So, in examining Figure 11 we see that, to a first approximation, the antenna looks like a simple resistor in series with an LC network resonant at the center frequency. Lets start there. Figure 12 shows the result. We start by setting the Generator impedance to 72 ohms to simplify our work. We then set the load to 72 ohms and add a series capacitor and inductor. The capacitor/inductor circuit will be resonant at 14.167 MHz so that, at that frequency the antenna impedance will be purely resistive.

After adding the inductor and capacitor we begin the tuning process. By making the capacitor smaller and the inductor larger we can adjust the length of the arc passing through center. The effects of these adjustments are shown in Figure 12.

Actually, this is a fairly good model but we can do better. While the general arc is about right, we need to rotate the entire arc clockwise. This can be done by adding a transmission line in series with the LC network. Figure 13 shows this transmission line and adjustments to all elements. The result is a surprisingly good model for the dipole antenna over a quite wide frequency range.

Broadbanding

One of my favorite ham radio examples is the broadband matching of a dipole antenna. This example draws on many disciplines and has several surprises along the way. This material is discussed in depth in the *ARRL Antenna Handbook*, chapter 9, "Broadband Antenna Matching". Typically, this example uses the 80m band where the dipole does not have enough bandwidth to cover the amateur privileges. Here I use the 20m band but the principles are the same.

This project starts by examining the properties of a simple dipole. Figure 14 shows the SWR of a dipole 34 feet long and up 34 feet above typical ground. The load file is created by EZNEC. Note that the 2:1 SWR bandwidth is about 13.9 to 14.5 MHz, about 600 kHz wide. The goal is to widen the 2:1 SWR bandwidth. The first step is to better match the dipole using the traditional L network. Figure 15 shows the result of this match. The 2:1

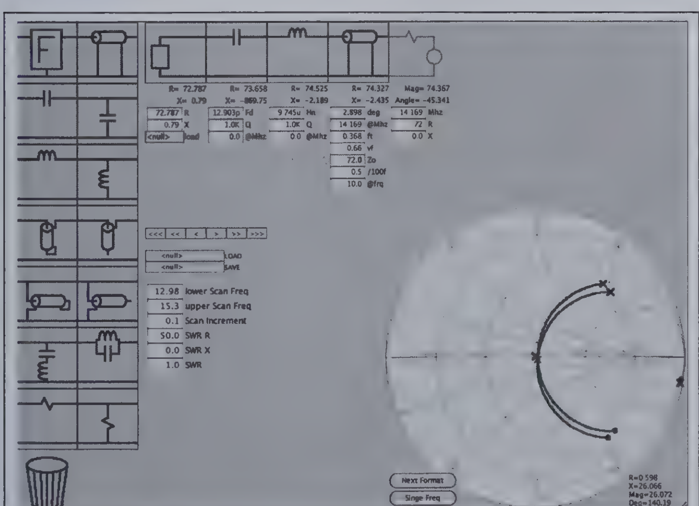


Figure 13—Adding a transmission line to the model.

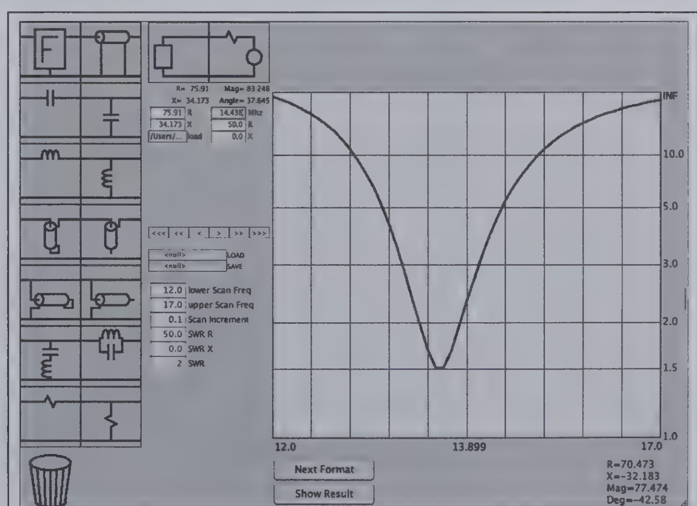


Figure 14—SWR plot for a practical dipole.

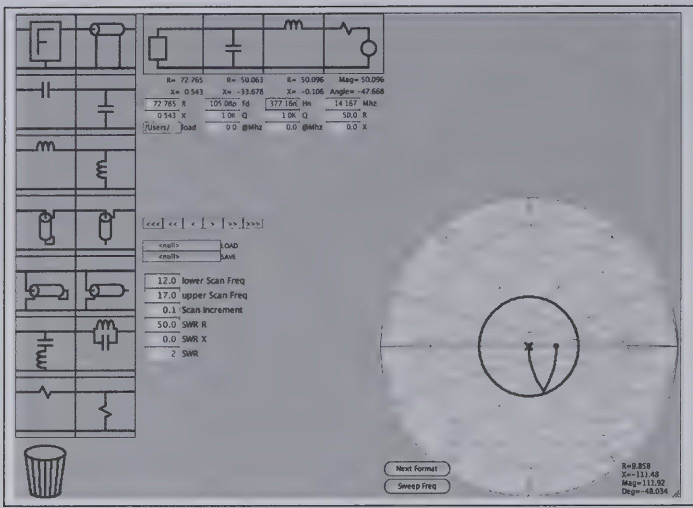


Figure 15—Extending frequency range with an L network.

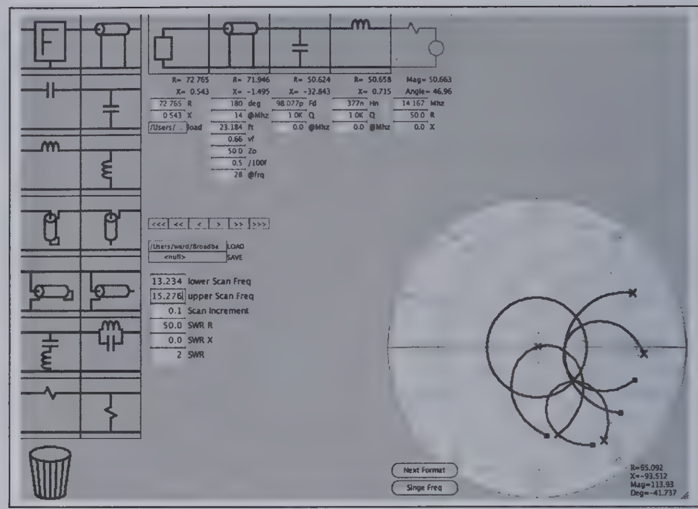


Figure 16—Adding a transmission line.

bandwidth has been extended to around 13.8 to 14.6, a modest improvement. However, as with any real antenna we need to introduce the feed line. Notice that Figure 15 also shows how SimSmith can draw the SWR circle. I simply set *SWR* to 2 and SimSmith drew the appropriate circle. The SWR can be around any impedance but it is typically drawn around the normalized impedance as specified by the Generator.

If I were to use best practices I would place the LC matching network directly at the feed point of the antenna. After all, I want the SWR on the feed line to be as close to 1 as possible. However, this is not what your average amateur does. Rather, the average amateur will use an antenna tuner to implement the match. So, I'll place the feed line between the match and the antenna. I'll make this feed line 1/2 wavelength long. The observant reader will note that I have retuned the LC network to account for the additional reactance introduced by the non-ideal transmission line. Figure 16 is the result. Note that the inner circle is the *path taken by the X* due to the 1/2 wave feed line. As one might expect, adding this feed line doesn't really change the SWR so I won't bother to show the plot.

But, we aren't done. In Figure 16 I have SimSmith sweep the frequency. Note that SimSmith shows the path taken by X for all the components, not just the final result. The final trace is the one that goes through the center of the chart.

Figure 16 is very interesting because it shows that there is room for significant improvement in improving the SWR bandwidth. Specifically, if I could move the final curve I could significantly improve the 2:1 SWR bandwidth. As expected, I can move this curve simply by adjusting the LC network. I did so and Figure 17 shows the result. I have adjusted the Sweep lower and upper frequencies so that the entire curve fits within the 2:1 SWR circle. Figure 18 shows the SWR plot for this arrangement.

Notice that the 2:1 SWR bandwidth is now nearly 1.9 MHz. That's over 3 times the original.

As I said before, this is one of my favorite amateur radio examples. One reason I like it is because it shows how a simple LC match can improve the match between a simple dipole and the transmitter; nothing radical, but informative to the beginner. Another reason I like it is that it shows that the 1/2 wave feed line has little effect on the system even when the feed line is not

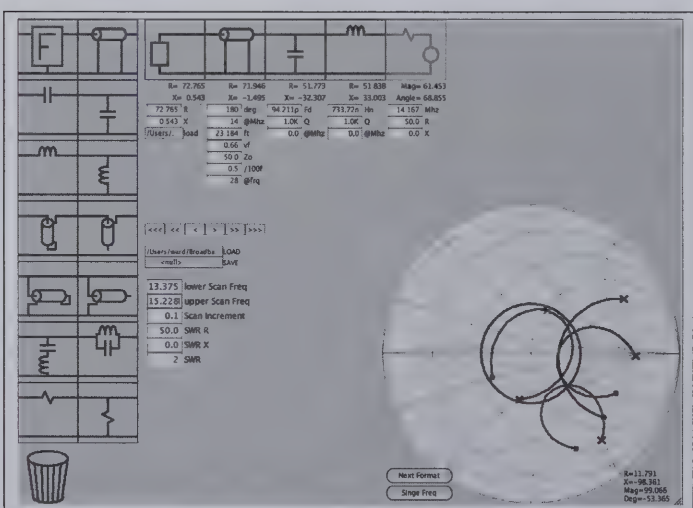


Figure 17—Adjusting the L network to broaden frequency range.

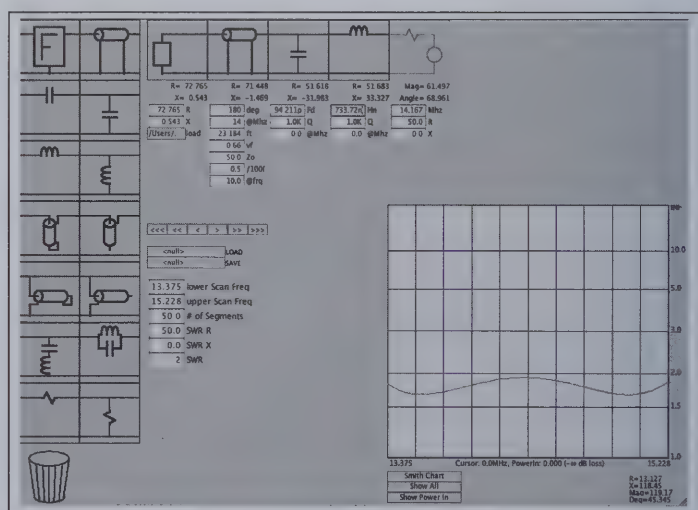


Figure 18—Corresponding SWR plot for optimized dipole.

matched. But the REAL reason I like it is because it shows that with a little exploration, one can do much better. The feed line can do more than be invisible. It can significantly improve our antenna/feed line system. And… the Smith chart is a terrific mechanism for doing this exploration!

Wrapping Up

Since its inception, the Smith chart has been used to perform calculations and gain insight into the intricacies of transmission lines and complex impedances. While the modern computer has supplanted the Smith chart as an aid to calculation, the Smith chart remains an important display technique. With the computer doing the heavy lifting and the Smith chart graphic providing the insight and guidance, the designer is freed to concentrate on the goals and the path toward achieving them. Modern Smith chart software represents a prime example of the melding of the traditional and the leading edge. I expect the Smith chart to hang around a long time to come. ●●

Appendix A: Expression Syntax for F Element

(Note: Syntax for the F element changes occasionally. The reader is advised to visit www.ae6ty.com for the latest version.)

Expressions are always computed in complex arithmetic. Several unusual operators are available

R means 'resistance' so you can write "Ra". An unadorned number works.
X means 'multiply by j' so you can write (Ra + Xb)
j means the same thing. You can write (5 + j10)
w means omega. You can write "jw5u" for an inductor of 5u
L means 'inductor with value' so you can say La or L5u
C means 'capacitor'
I means 'value on the left of the F block'
T(Zl,length,Zo) transmission line.
"|" means 'in parallel' and is higher precedence than multiply.

Here's an example T matching equation: "(I + Ca) | Lb + Cc" and a Pi matching network might be "((I | Ca) + Lb) | Cc"

All spaces are ignored so "123 456" is the same as "123456".

A not so formal definition follows:

<expression> := <sum>

<sum> := <product> or <product> "+" <sum> or <product >"-" <sum>

<product> := <parallel> or <parallel> "*" <product>
or <parallel> "/" <product>

<parallel> := <unary> or <unary> "|" <parallel>
<unary> := "+" <unary>
or "-" <unary>
or <func>

<func> := "I" // I is the value to the left of the F block.
or "C" <func> or "L" <func>
or "R"<func> or "X"<func>
or "j" <func> or "w"<func>
or <TLine>
or <parens>

<TLine> := "T("<sum>,<sum>,<sum>")" // T(Zl,length,Zo)

<parens> := (<sum>) or <number>

<number> := <constant> or <variable>

<constant: := <decimalNumber> [<units>]

<units> := "f" or "p" or "n" or "u" or "m" or "k" or "K" or "M" or "G" or "T" or "P"

<variable> := "a" or "b" or "c" or "d" or "e" or "f" or "g" or "h"

<decimalNumber> := Just what you would expect

Listening to Receivers

Rick Campbell—KK7B ecekk7b@gmail.com

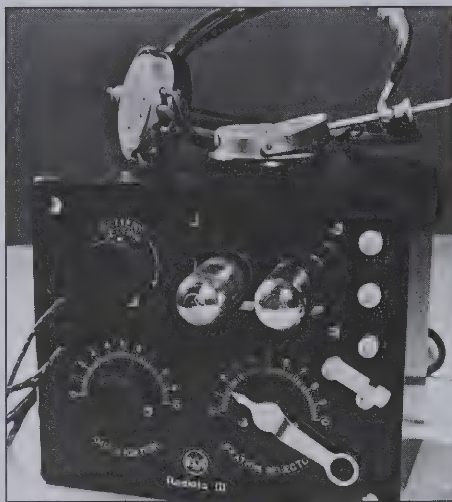
It is easy to forget that an ideal receiver for one user and application may be the worst possible choice for another use. This is particularly true for today's commercial radios with extensive menu choices that allow one to adequatize the radio for nearly any application. (Adequatize is a synonym for optimize, but with the bar set much lower.) The custom designer/builder/user has the opportunity to design and build a radio for a specific purpose--and then evolve the design to meet the needs of actual on-the-air conditions that the operator encounters. Choosing a specific application and then allowing the design to evolve gives the designer/builder/operator a powerful advantage over a consumer who studies the available commercial products and then makes a purchase.

If you have more than one application, build more than one receiver. There is no single design that fits every purpose, and as performance is optimized for one use, necessary features for other uses may be compromised or eliminated. One way to think about receiver design is to think about how we listen to receivers intended for different applications. Each of us has different experience, and I'll discuss a few receivers that I have designed and have extensive experience operating. The categories I've chosen are: communications receivers; weak-signal receivers; instrumentation receivers; competition grade receivers; and classics.

Communications Receivers

Communications receivers have their origins in message traffic networks, aircraft and ship communications, and long distance radio relay systems. During the first half of the 20th century, radio operators were skilled professionals or amateurs of equal ability. Receivers were simple, but required skill to operate. Starting around the time Amelia Earhart failed to properly use her radio, communications receiver design began to focus on ease of use.

One might argue that communications receiver design reached a pinnacle in the Citizens Radio Service during the 1960s and 1970s with designs so advanced that no skill at all was needed to effectively



communicate. Or one might consider shipboard UHF AM systems that permitted officers on the bridge to communicate with a nearby ship simply by picking up a handset and remembering to press a button to talk—oblivious to the patch cords, frequency selection, etc., handled by the radioman below deck.

For unskilled users, it is important to keep adjustments to a minimum. AM and FM have relaxed frequency tuning requirements, and automatic gain control allows one to set the volume control once and leave it alone. Single sideband has never quite achieved the same ease-of-use, but modern transceivers are close, particularly at HF where the frequency can be simply dialed in and left alone. As long as one is willing to sacrifice voice quality and information about band conditions, signal strength, and antenna effectiveness, aggressive automatic gain control and extensive digital signal processing may allow even a completely unskilled operator to get the message through on voice.

When conditions are difficult, skilled operators usually choose a different mode when getting the message through is critical. Communications receivers have an important place in radio. Even skilled operators need easy-to-use gear when operating bicycle mobile or when running emergency communications in the dark. An ideal communications receiver sounds OK and has good AGC.

Weak Signal Receivers

Many of the most experimentally inclined and advanced designer/builder/operators focus on extremely difficult propagation paths such as Earth Moon Earth. On EME, signals are always weak--in fact the total noise power in the received audio channel is usually stronger than the recovered signal. Weak signal VHF-UHF-Microwave operation has similar conditions. Many active Central States VHF Society members live more than 100 miles from the next nearest VHF station. Portable operation is common on UHF and microwaves, and the portable station is usually located as far away as possible to keep contacts interesting.

In all of these types of operation, interference is rare, and strong signals are seldom encountered. When signals are always near the noise floor, AGC has no value, and it can degrade the intelligibility of weak signals by adjusting the gain to keep the average noise power constant. On EME, the strongest signals are less than 20 dB above the noise floor, so EME receivers need little dynamic range inside the audio channel. This allows extremely effective weak-signal DSP algorithms such as those written by Joe Taylor to operate on the receiver audio output using only a simple computer soundcard.

Weak signal operators spend hours listening to noise, and low distortion and good headroom inside the audio channel provides a high-fidelity noise spectrum that is much more pleasant listening for hours on end. An ideal weak-signal VHF-UHF and EME receiver has low distortion, a flat passband inside the channel, good audio, and no AGC. The original R2 was designed specifically for high-performance VHF weak signal applications. Some experienced weak signal operators listen using a speaker in a quiet room, and move their head and ears around to find the sweet spot in the room that optimizes signal recovery.

Instrumentation Receivers

Some of us are more interested in radio science than radio communications. When I tune across the 40m band, I'm more interested in where the signals and noise are coming from than whether or not I have a particular DX station in the log. When Wes

Hayward and I go out on Field Day, he's amused that I spend most of my time listening, and make few contacts. During my 13 years in Michigan's Upper Peninsula, I experienced aurora propagation on 144 MHz a few nights a week, and I found it more interesting to listen to the signals, aim the antennas around and find the peaks, and make Doppler sketches of the auroral electrojet than to actually try and work anyone. When the aurora was strong, it was often to the south of me, and it was usually more enjoyable to go outside and watch the show than try to work DX.

On HF, an experienced listener can tell by the sound of a signal whether it is local, one-hop, two-hop, over-the-pole, or gray line propagation. The sound of the band noise will reveal whether the band is open, and to where. For listening to the band, AGC is not useful, and filtering with a flat response and graceful rounded skirts for good impulse response is desired. Any kind of digital signal processing is likely to alter the signals and band noise in a way that suppresses the subtle cues that an experienced listener can hear. Somewhat ironically, this is also the optimum receiver to serve as a front end to advanced signal processing routines written in advanced programming languages for post-processing of the received signals.

I have been designing and building receivers for advanced listeners and for advanced post-processing algorithms since 1980. I call them Instrumentation Receivers, and the R2pro and microR2 are good examples. Each was originally designed for a specific professional instrumentation application, and the Kanga US kit circuit boards were spun off because they work so well for some amateur applications. They have no AGC, flat passband responses with rounded corners and graceful skirts, nearly flat phase response across the passband, and more than 80 dB noise floor to distortion headroom inside the audio passband. In contrast, a typical amateur transceiver may have only 30 dB of headroom in the audio channel, and rely heavily on AGC to keep the signal levels within that narrow window.

Competition Grade Receivers

If communication receivers were designed for unskilled operators, the competition grade receiver was designed for a highly skilled operator in competition with others trying to pick out weak signals in the presence of nearby strong signals, on a packed band. More than any other kind of receiver, the Competition Grade receiver was actively driven by the operator. A skilled operator can copy one of several signals in a passband, even when they are only a few Hz apart—too close for passband tuning to be effective. The competition grade receiver included an assortment of interference and noise suppression tools that might sacrifice sound quality for extreme selectivity etc. but were easily switched in and out when needed.

But times have changed. Since modern radio contest scores all involve maximizing the number of contacts made during a given time period, it is becoming common--essential in some contests—for the radio to be under direct computer control. A computer is not a skilled operator. Many of the requirements for computer-to-computer communications are the same as for radios operated by humans with no skill. It has been interesting to watch the evolution of competition grade radio hardware as the role of the human with the call sign has gradually changed from Radioman to IT Professional.

As with competition grade sailing yachts and race cars, today's bleeding edge radios will be in the landfill in a few short years. Computer hardware and software has the shortest half-life in the history of technology. I have spent my professional career designing analog and digital radio hardware. Some of my designs been wildly successful, but nothing that involved digital signal processing lasted more than 5 years. AGC, DSP, DDS and the rest of the alphabet are all needed.

Classics

Each of the previous receivers is designed to perform a particular function. Looking back over the history of radio, we find some classics: radios that went beyond basic function, defined an aesthetic and appealed to the senses. There are also classic operating activities: casually tuning across a band in the evening to check propagation; a morning sked with friends; backpacking with a portable CW rig; Straight Key Night; competition grade performance on a single band and mode. Radios designed and built to appeal to the senses and work well for classic operating activities are in a separate category from

communications receivers, weak signal receivers, instrumentation receivers, and competition grade receivers. They provide performance and operating enjoyment in equal measure. The appeal is visual and tactile in addition to the way they sound. If they include vacuum tubes and power transformers, they even smell good. A classic radio doesn't operate entirely in the present tense.

There are two approaches to classic radios: as a curator and as a designer/builder/operator. A curator finds and restores a vintage receiver to its original condition, sharing information with other vintage radio enthusiasts and embracing the limitations of technology from an earlier era. A classic designer/builder/operator combines appealing and functional old technology with more recent understanding and hardware, to produce a modern classic. Beauty is subjective, and one man's aesthetic may grate at another man's senses. But radios that sound good, have positive, silky smooth tuning, and look nice sitting on the desk next to an old *Radio Amateur's Handbook* will always have a place in my life.

Summary

The R2pro and other receivers I've designed work best as the RF/analog signal processing core of weak signal, instrumentation, and classic receivers. I have also used them to build communications receivers and competition grade receivers for specific bands and modes, but I find that for those applications a modern commercial appliance may have significant advantages—particularly when computer control is required.

I don't use AGC for weak signal, instrumentation, and classic receivers,

except sometimes for ear protection when using headphones in noisy environments. My listening style has always started with a quiet space. When I was 17 years old, I lived for 3 months in the deep woods, far from the nearest highway. I enjoy listening to distant sounds on a quiet night. The amazing dynamic range of the ear-brain is sacrificed when a radio is turned up loud. When listening to a classic receiver, I prefer a quiet room. During some periods in my life I've limited my radio activities to hours when the rest of the neighborhood was asleep.

The R2pro has 80 dB of headroom in the audio channel between the noise floor and onset of audio peak clipping. By setting the clipping threshold loud but still comfortable on the loudspeaker, the weakest signals are still audible in a very quiet room, and moderate signals stand out against a quiet background like the soloist in a quiet concert hall. That is a very different experience from listening to a communications receiver with the volume turned up and AGC lowering the gain for every received signal.

On the topic of AGC, the first question needs to be "how do you listen?" The next question is "Why do you want to automate the control of receiver gain?" You spend only a little time listening to your receiver, and the rest of your time listening to the world. The world does not have AGC.

—de KK7B

About this essay:

Used with permission, this comes from the Files section of the "r2pro" discussion group on Yahoo.com; Rick felt it was too long for a regular posting to the group. Created in 2005 by Bill Kelsey, N8ET, the group "is set up to discuss the R2Pro receiver and other KK7B designs that have been published in the past several years. The list of designs includes the R1, R2, R2Pro, MiniR2, and BIQR receivers, the T2 transmitter, and the LM-2. It will provide a forum for the exchange of information and ideas about the designs." (Bill operates Kanga US, which has kits for some of the KK7B designs.)

[Photos were added by the editorial staff and were not part of the original article.]

QRP—Quaffed Ready to Pour

Pete Juliano—N6QW radioguy90@hotmail.com

Often we take life too seriously, such as about a week ago when my Fall issue of *QRP Quarterly* did not arrive as expected. Having the *QQ* in my hot little hands was absolutely critical to a plan I had been hatching for some time. Naturally we all want to get our hands on this wonderful pure ham radio periodical devoted to the QRP enthusiast. But I needed to have my copy right now and why don't I have it!

Backing up a bit, I need to confess that I had an article published in the Fall issue of *QRP Quarterly* and I couldn't wait to have that issue prominently displayed on my coffee table. I should also confess that we are having guests over for Thanksgiving Day. Of course, I would clear my throat and announce, "Ahem! Did you know I am a published author?" Then I would point to the coffee table where all of the guests could see my name and call sign prominently displayed on the masthead.

Well as long as we are being truthful, one neighbor who was invited over for dinner is a golf nut and he is regularly published in golf magazines. I just wanted to be able to say at least once that I am published too! But my hopes were dashed on the rocks—no Fall issue and Turkey Day was getting close. A quick call to one of the *QQ* Editors indicated the Fall issue was mailed and somehow mine was stuck in the mail. Bummer!!! ...with a Big Capital B. Would that issue arrive in time for Turkey Day -what a spot to be in? My one big chance to outdo the golf nut and it was lost in the mail!

As luck would have it the very next day I received a call from the one of the neighbors down the street who fancies himself a wine connoisseur. The voice on the other end of the phone announced that he had mistakenly received my wine magazine. I answered that I do not subscribe to any wine magazine and he said, "Yes, you do, as the return label clearly indicates: Quaffed Ready to Pour Quarterly." That comment caused both moments of a big Question Mark and Absolute Joy! His *Quaffed Ready to Pour Quarterly* was my *QRP Quarterly*. It was here and I would be able to execute my grand plan. I wasted no time making way to my neighbor's home to retrieve my precious issue. I just hoped it had not sustained any damage from spilled wine. Oh, what joy!

On my way down to his QTH, I was suddenly struck about the abbreviations and acronyms we use daily when talking about QRP and ham radio that are unique to our hobby. Oh, Oh! That started me think about other abbreviations we use and how they might be misunderstood by those less fortunate than us who don't have ham licenses. You know where this is headed and it is not good.

For instance, consider the word VOLT. We all know what a volt is—a unit of electromotive force. But our computer cousins would say that it is View On Line Text . One of the most frequently used words (as it shows our techie side and sounds almost mystical) is VSWR, which of course is Voltage Standing Wave Ratio. To those with a flair for cooking that could mean

Vegetables Steamed With Rice. Perhaps the editors would consider running a contest to determine how many of our standard abbreviations could be interpreted in an entirely different context. That might be fun! Here's a few to get you started:

QRP: Quaffed Ready to Pour

VOLT: View On Line Text

VSWR: Vegetables Steamed With Rice

SDR: Salad Done Right

WSPR: Whiskey & Soda Poured Right

HAM: Hold At Middle

SHACK: Specialty Ham And Cheese Knockwurst

BUG: Bratwurst Under Glass

OK now it is time for you to confess - how many have you come up with as you are reading this short article?

On my way back after collecting my precious *QRP Quarterly* I thought again how Hams and especially QRP enthusiasts have always been in the forefront of advancing technology. Kids of today, and I say kids ranging in age from 10 years to 16 years, believe they have given the world a huge gift by what they consider is their invention—Text Messaging. Hey we have been doing text messaging for over 100 years and it always has been at the speed of light—none of this cell tower stuff!

Consider this text message:

"HI OM, TNX FER UR RPT, UR 599 HR AT MY QTH NR SEA. OP HR ES PETE, DE N6QW." And of course— "WX RAIN, RIG HR K3, PWR 5W ES ANT DPLE. TNX ES 73s DE N6QW"

That sure was clear to me about the signal report, the weather, the radio being used, the power level and the type of antenna, the location is Seattle and the operator is Pete. Oh the call sign is N6QW and from QRZ.com I will know the grid square (CN88) and the mailing address and the class of license. So tell me again who invented text messaging?

Lest we forget, the power level coming out of the cell phones is relatively small. Although there is some conjecture that the frequency range is such that even a small amount of power combined with excessive use can fry your brains, Now I know why those young kids act as they do. But don't jump over the low power too quickly as there are cell towers virtually everywhere and big computers to control traffic so that wide area coverage is possible using milliwatts.

But think about QRPers like Mike Rainey, AA1TJ, who have built radios from 1950 vintage transistors that are running milliwatts (and/or microwatts) and have spanned the Atlantic on 80M CW with ostensibly a long wire antenna. So tell me again about cellular text messaging.

And just think, I have pulled you all the way to the end of this article just because the U.S. Postal Service put my precious *QRP Quarterly* in the wrong mailbox. That said, we should be very proud of our hobby and the many hams worldwide who have made many significant contributions to not only ham radio but to the world in general.

Now, what I am really waiting for is that unsung ham sitting in a cold garage somewhere in the U.S. who has written an application where you can take your iPhone and by using text messaging have a QRP QSO on 40M. That may be just a few months, if not a matter of weeks away. Ooops! I am sure someone reading the article will say, "I have been beta testing such a device for several weeks now." Please identify yourself and give us a report.

—73 de N6QW

2011 FDIM Information Summary

Dates:	Thursday, May 19 through Sunday, May 22
Location:	Holiday Inn Fairborn, Fairborn, OH (Dayton area)
Registration:	Online—www.fdim.qrparci.org
Hotel:	Through QRP ARCI only—info at www.fdim.qrparci.org
Seminar:	Thursday, May 19, 8 a.m. – 4 p.m.
Activities:	Buildathon Homebrew Contest Show & Tell Vendor Night Meet the Speakers Guest/Spouse Program Awards Banquet (with many door prizes) And of course, the Dayton Hamvention®

CU at FDIM!

QRP Contests

Jeff Hetherington—VA3JFF contest@qrparci.org

The Winter issue of *QQ* always has the shortest Contest Column. Only two contests, the End of Summer VHF Contest and the Fall QSO Party, have entry deadlines that allow for the results to be finalized in time to reach our print deadline. Starting in 2011, with a shorter two week deadline after the contests for entries to be received, we will be able to report on three contests each quarter and balance out the reporting. Please remember to submit your logs after the contests are done in a timely manner, as entries received after the two week entry deadline will only be considered as checklogs.

The End of Summer VHF Contest ran once again in the September time slot, and there were a few more entries this year. However, hopefully we will continue to see an increase in the QRP participation in this contest, as for the first time in my history as the Contest Manager, we had more QRO entrants than QRP entrants in a contest! The contest winner was Dan Fegley, W1QK with an impressive total of 22,243 points on 328 QSOs. Dan was in the greater than 10 watt power category, but an impressive total none the less. The two QRP entrants rounded out the top three with Doug Phillips, W7DRP taking home second prize with 6,930 points in staying ahead of third place finisher Jim Stafford, W4QO and his 180 point total.

The Fall QSO Party was once again our most popular event of the year, attracting 93 entrants from five countries. 2010 was the first year of the multi-operator category for the Spring and Fall QSO Parties, and this Fall we had two multi-operator entries fighting for the title. The Knightlites, WQ4RP were the first ever multi-op champions in a QRP-ARCI event, scoring a total of 173,628 points in defeating the Houston QRP Club, W5MSQ and their total of 28,616 points. Keep the multi-op fun and camaraderie going; I'd like to see this as a growing category in the year to come! The single operator category was won by Bob Patten, N4BP who was the only operator to clear the million point mark with 1,666,889 points. Jim Lageson, NØUR took second with 934,276 points, while Brian Kassel, K7RE and Randy Foltz, K7TQ found for third and fourth with 870,317 points and 837,928 points respectively. Rounding out the top five was Joe Vrabel, KD2JC at 512,736 points. Interestingly, the top four scores were all members of the winning team as well. The original Aluminum Kings team of Bob Patten, N4BP, Jim Lageson, NØUR, Brian Kassel, K7RE, Randy Foltz, K7TQ and Al Dawkins, KØFRP re-united and took the team total with a dominating total of 4,653,831 points. Who will step up in 2011 to take a shot at removing the Kings' crown?

Mark Your Calendars

2 & 3 April 2011	**Spring QSO Party**
29 May 2011	**Hootowl Sprint**
25 & 26 June 2011	**milliWatt Field Day Contest**
10 July 2011	**Summer Homebrew Sprint**

This past year I have noticed an interesting change in the logs that have been received for our contests. When I began as the contest manager in 2005, the logs were dominated by operators that were using the K2. Log after log was typed in showing the K2 as the rig of choice. Furthermore, there were some FT817s, K1s, and the popular kit rigs and that led to the vast majority of entrants opting to utilize QRP radios. Fast forward five years to 2010, and more entries seem to be using throttled back QRO rigs. Not wanting to try to over analyze this information, here is a summary of the rigs used in our two most popular contests in 2010:

- Twenty-one operators used the Elecraft K3
- Twenty operators used the Elecraft K2
- Eleven operators used the various versions of the Ten-Tec Argonaut
- Ten operators used the Elecraft K1
- Nine operators used the Yaesu FT817
- Seven operators used the Icom IC703
- Fifteen operators used other various QRP rigs/kits
- Twenty-nine operators used various other Yaesus
- Six operators used various other Ten-Tecs
- Six operators used the Ten-Tec Orion
- Six operators used the Yaesu FT1000
- Five operators used various Kenwoods
- One operator used a Drake TR5

What does it all mean? Perhaps, it's just an indicator that the next great QRP rig is just around the corner, ready to be introduced, catch our imaginations and take our QRP operating to the next level. Perhaps, it's just an indicator that the word is getting out about how much fun QRP contesting is, and that more mostly QRO types are turning the dial down to five watts or less and joining us on the bands! Either way, 2011 looks like it will provide plenty of opportunities for all to enjoy the airwaves!

I hope that everybody had an enjoyable holiday season, and that everyone is as excited about 2011 as I am. Heres hoping that it will bring you all good health, good fortune and good times.

Until next time, keep your power down and your QSO rates up.

—73/72, Jeff, VA3JFF

End of Summer VHF Contest—

Top 3 Finishers	
Dan Fegley, W1QK	22,243 pts
Doug Phillips, W7RDP	6,930 pts
Jim Stafford, W4QO	180 pts

Soapbox

Wanted to try out my new beam. It is certainly directional. Unfortunately could

2010 End of Summer VHF Contest Results									
CALL	STATE	BANDS	POWER	#QSO's	PTS	Grids	Mult	SCORE	RIG & ANTENNA
W1QK	CT	50/144/220/440	> 10W	328	377	59	1	22243	IC-746PRO
W7RDP	WA	50/144/440	< 5W	56	66	15	7	6930	FT817, 6m Moxon, 3el 2m Arrow, 7el 70cm Arrow
W4QO	GA	50/144	< 10 W	9	9	5	4	180	FT847, 80m Horiz Loop
K4BAI	GA	50	> 10 W	6	6	4	1	24	IC736, 6 ele M2, 5 ele Yagi
N8OFS		50	> 10 W	9	9	1	1	9	TS60, Dominator
N4BP	FL	50	> 10 W	4	4	2	1	8	K3, Cushcraft A505S

only find a few other stations in Georgia for local QSOs. **—K4BAI**

Operating from AC&J Railroad Caboose **—N8OFS**

No opening during the times I listened. **—N4BP**

ARCI Fall QSO Party

Top 10 Finishers	
Bob Patten, N4BP	1,666,889 pts
Jim Lageson, NØUR	934,276 pts
Brian Kassel, K7RE	870,317 pts
Randy Foltz, K7TQ	837,928 pts
Joe Vrabel, KD2JC	512,736 pts
Willie Baber, WJ9B	490,364 pts
John Thompson, K3MD	479,325 pts
John Watkins, NØEVH	435,120 pts
Paul Beringer, NG7Z	384,888 pts
Al Dawkins, KØFRP	344,421 pts

Fall QSO Party Team Competition

Aluminum Kings (N4BP, NØUR, K7RE, K7TQ, KØFRP)
4,653,831 pts

NoGAnauts (W4QO, W4DU, WU4B, WB4MAK, W4JDS)
372,708 pts

Beaverboys #2 (VA3RKM, VE3EUR)
298,788 pts

MONTeam (EA2LU, EA2IF, EA4CN, EA2AZ, EA2BVV)
238,917 pts

Beaverboys #1 (VE3WMB, VE3GTC, VE3HG)
59,052 pts

Soapbox

This was an entirely different contest than the Spring Party in April. All day Saturday and into the evening, it seemed like participation was way down. Conditions were good on 20 & 15, but just could not get any volume going. The multiplier was looking dismal when I quit Saturday night, but Sunday made up the difference in spades! All day long, 15M was skipping into different areas of the US, and even 10M opened for a while. When the dust settled, 15 & 10 provided enough mults to more than exceed the Spring Party totals. Total QSOs were down a bit, so the final score was a bit less, but still very satisfying. Worked KH6U on 10/15/20, W4OV (FL) on all six bands, K3HX on five bands, and thirteen QSOs with my four Aluminum Kings team mates. Other than local W4OV, WQ4RP of Knightlites fame was my only QSO on 160M—and a terrific signal at that! Recovering from prostate surgery with the accompanying frequent bathroom trips, so this was a test to see how long I could stay in the chair. Including the BR sprints, I endured for 23 hours. **—N4BP**

A good turnout especially on Sunday. Good to contact several old friends. **—K7TQ**

Conditions were great, 15 meters was wild! I totally enjoyed it. I think this is one of my best efforts in years. **—KD2JC**

That was one rough Fall event. Bands so so with lots of QSB and loads of digital stations where we normally play radio. Gud to hear old friends and meet some new ones. **—NØEVH**

This turned out to be a very active QSO party. Good to hear the familiar calls again. My time was limited to about 9 hours but it was very productive time. There could have been more activity on 15m. The band seemed open as I could here N4BP there consistantly and I worked WA and OR as well. Thanks to all for the contacts. **—WØUFO**

I felt sorry for the western ops who were calling in the later evening on 40m but with little response. The price of living in the west. Spain is well-represented again this time. I worked three EAs. Wish we could get more VE sections involved. Tnx for the Qs! **—VA3RKM**

Had a great time operating— the bands were in decent shape and some old familiar callsigns were good to hear. **—AE5X**

Saturday no operating because of near fest ham flea market and my usual radio show. I'm happy to have 15 metres useable again; 15 game most QSOs, 40 opened in last 20 minutes. **—KØZK**

Always great fun! Surprised at amount of activity on 80m. **—K3HX**

Had a lot of fun in limited time. **—W4QO**

Very good contest, with good weather and wonderful companionship with the group. Got a chance to operate the Flex 1500 for the first time in the contest (AB4PP) **—WQ4RP**

Condx so much better than last yr. This time it was fun. **—WD7Y**

Great conditions on 21 MHz, unfotunately I spend one hour on 7 MHz saturday night seeing the NA "gray line" but no traces of any station from NA. Thanks you all for the great fun, my third ARCI QRP contest, always entertaining. **—EA2LU**

Neighborhood QRN was S9 on both 80 and 40. The blanker helped, mostly on 40. My apologies to those stations whom I was unable to copy through the QRN. **—W8TM**

Had a great time—thanks to everyone who copied my signal. Could have used better propagation and less RTTY—but I'm getting used to it! **—WA5RML**

Original intent was for a token effort to test hastily built attic dipoles at new QTH, with no real planning for time over the weekend. Just happy to be QRV. But the antennas worked better than expected and conditions were good, so it became great fun despite fragmented op time. Thanks for the great time. **—K4KSR**

I enjoyed again this nice contest. More participants would be welcome. I hope to be on for the 2011 Spring event. Have a nice winter. **—EA2IF**

2010 QRP ARCI Fall QSO Party Results								
Call	**STATE**	**BANDS**	**#QSO's**	**PTS**	**SPC**	**Mult**	**SCORE**	**RIG & ANTENNA**
N4BP	FL	ALL	382	1577	151	7	1666889	K3 + A4S, Sewper Armadillo Trap Dipole, 160m Inv L
NØUR	MN	ALL	255	1094	122	7	934276	
K7RE	SD	ALL	290	1231	101	7	870317	IC706 + 160 vertical, dipoles, 3 element tribanders
K7TQ	ID	ALL	273	1151	104	7	837928	K2 + Force12 C4SXL, 1/2 sloper on 80, 160m inv L
KD2JC	NJ	ALL	203	872	84	7	512736	K2 + 40m loop, G5RV, tri-band yagi
WJ9B	FL	ALL	211	844	83	7	490364	TenTec Eagle and Orion + 15M4, 20M4, loop, dipole
K3MD	PA	ALL		825	83	7	479325	IC7800 Loop
NØEVH	MO	ALL		740	84	7	435120	K3 + Inv L
NG7Z	WA	ALL	145	632	87	7	384888	SO2R IC756 + Force12 C3, 40-2, 80m quad loop, 160m inv L, super loop, Butternut HF6V
KØFRP	CO	ALL	174	693	71	7	344421	
WØUFO	MN	ALL	132	603	73	7	308133	
VE3MGY	ON	ALL	144	528	58	10	306240	
VA3RKM	ON	ALL		586	66	7	270732	K2 + Vertical, wires
AE5X	TX	ALL		532	69	7	256956	
KØZK	ME	ALL	110	485	71	7	241045	K3 + 30ft ground plane on roof of quonset hut
K3HX	PA	ALL	122	515	65	7	234325	Orion 1 + Triband rotary dipole, dipole, inv L
W4QO	GA	ALL		448	59	7	185024	FT1000 + 80m horiz loop
WQ4RP	NC	ALL	114	468	53	7	173628	K2, Flex 1500, KX1, Sierra, Corsair + Dipoles, TH6, 160m vertical, 15m moxon
WD7Y	NV	ALL	85	395	56	7	154840	Orion 2 + 102ft doublet, butternut vertical
WA5BDU	AR	ALL	91	423	52	7	153972	K3 + Dipole, tribander
W4DU	GA	ALL		361	58	7	146566	K3 + Tribander, 80m inv vee
EA2LU	Spain	ALL	81	371	53	7	137641	IC7800, K2 + X7, HF2V
AI2T	NY	ALL	91	391	50	7	136850	K1 + CF Zepp, 3 ele Yagi
W8TM	OH	ALL	87	379	46	7	122038	K3 + 40m inv vee
WA5RML	TX	ALL	65	312	48	7	104832	FT817 + Dipole, Vertical
K4KSR	VA	ALL		322	44	7	99176	K1 + Attic Dipoles
K3WW	PA	ALL	76	322	43	7	96922	K3 + 402CD, Skyhawk, vertical
EA2IF	Spain	High	73	337	40	7	94360	TS940SAT + TH5-DX
W5ESE	TX	ALL	61	293	46	7	94346	Argonaut 509 + 100m HOHPL
K5TF	GA	40		415	32	7	92960	FT920 + Bazooka Inv Vee
WA7LNW	UT	ALL	62	289	41	7	82943	
W1PNS	MA	ALL	64	282	41	7	80934	FT817 + 20m dipole
N8LA	MO	ALL	58	272	42	7	79968	Argonaut 515 + 200ft dipole
N2CQ	NJ	ALL	64	249	35	7	61005	
WØRSP	AZ	ALL		215	36	7	54180	Sierra + Dipole
NK6A	CA	High	48	234	33	7	54054	K3 + Force12 C4, EZ88
N1LU	NH	ALL	43	203	33	7	46893	IC746 PRO + Cobra Ultralite
NA3V	PA	ALL		214	29	7	43442	IC756 Pro I + 120ft doublet
W2JEK	NJ	ALL	44	195	30	7	40950	FT840 + 15/40 dipole, gnd plane 20m, endfed 80m wire
WR4I	VA	20/40	39	174	32	7	38976	
VE3WMB	ON	ALL		190	25	7	33250	Argonaut V + G5RV, 4BTV
K7DD	AZ	High	33	153	31	7	33201	
KN1H	NH	ALL	38	175	27	7	33075	IC718
N3SW	PA	ALL		163	26	7	29666	Omni VII + Doublet
K4KJP	AL	ALL	32	174	24	7	29232	K2 + Hustler 6BTV

QRP Contest, 3 state QSO parties, and 4 new caribbean DXCC entities all on 7.030, but still great fun! —**K5TF**

First time operating this contest from MO. Closer to centre of continental US, not as hard to work states. —**N8LA**

15m was OPEN!!! surprisingly great, given the sparse activity up there! Check 15m and 10m from now on—even though the SSN <48 and Solar Flux is limping along below SFI=94 at its latest peak, the high bands are cooking! —**WØRSP**

Propagation was not bad. Operating schedule was pretty casual but had a lot of fun. —**VE3WMB**

Good participation; lots of QSB; and lots of fun! —**K4KJP**

Damn...isn't QRP fun? —**K8ZFJ**

Operated Multioperator /P, all from a farm in Brookshire, TX. —**W5MSQ**

Well, that was fun but I wish I had had more time to compete. I managed to bag a few notable QSOs—RI, SD, WA, ME, and ID—but missed the EA2. This was, I

Call	STATE	BANDS	#QSO's	PTS	SPC	Mult	SCORE	RIG & ANTENNA
K8ZFJ	RI	ALL	29	138	21	10	28980	IC703+ + G5RV
W5MSQ	TX	ALL	32	146	28	7	28616	FT817s + Horiz Loop, Verticals
VE3EUR	ON	ALL		167	24	7	28056	TR-5 + Inv L
VE3GTC	ON	ALL	32	148	23	7	23828	
WU4B	GA	ALL	29	141	24	7	23688	FT1000 + Dipole
VE2DJN	QC	20/40	35	157	21	7	23079	
KC4ZA	VA	ALL	31	149	22	7	22946	IC736
W2HWW	NJ	ALL		111	20	10	22200	Softrock RXTX + Butternut HF9V
K2ZV	NJ	40	57	165	19	7	21945	K2 + Alpha-Delta LB
K4BAI	GA	ALL	26	121	22	7	18634	
W3DP	PA	20/40	33	147	18	7	18522	FT840vCushcraft R7000
WB1HGA	MA	ALL		122	21	7	17934	Argonaut V + Carolina Windom
N4DL	FL	20	28	133	19	7	17689	FT857 + Hygain HV14 Vertical
WV1N	CT	20	25	112	15	10	16800	Wilderness Sierra + 135ft doublet
K4BYF	FL	20/40	26	118	19	7	15694	K2 + 3 ele 20m beam, 40m vertical
WA8HSB	AL	ALL		114	19	7	15162	K1 + Doublet, 2 ele wire beam
K4GHH	MD	40/80	33	150	14	7	14700	
KF4UCC	VA	20/40	25	116	18	7	14616	
WB8EJN	MO	20/40	25	104	20	7	14560	IC706mkIIG + 40m dipole, butternut vertical
WB4MAK	GA	ALL	22	98	21	7	14406	
W9FTC	WI	20/40	20	100	19	7	13300	K3 + dipole, TA33 triband
W5TTE	NM	ALL	20	97	17	7	11543	IC7000 + Ground mount vertical
KD5RSS	OK	20/40		97	15	7	10185	K1 + G5RV
WD8RIF	OH	ALL		90	16	7	10080	K2 + 88ft Doublet
K4JPN	GA	20/40		91	15	7	9555	K2 + 80m CF Zepp, 3 ele yagi
K4UPG	FL	20/40		91	14	7	8918	
VE3WDM	ON	ALL	18	64	17	7	7616	
AB4QL	AL	ALL	15	72	15	7	7560	K1 + Trap Vertical
N9XO	IN	ALL	17	82	13	7	7462	
W1PID	NH	ALL		83	11	7	6391	K2 + OCF Dipole
EA4CN	Spain	20	15	68	11	7	5236	FT920 + Tennadyne T6
WA3SEE	MD	20	12	57	11	7	4389	Dipole
KB1NHV	VT	ALL	12	52	12	7	4368	
AB8FJ	OH	ALL	12	54	10	7	3780	Argonaut II + End-Fed Wire
K3PG	MD	15/20	13	61	8	7	3416	FT1000
N2YHQ	NY	ALL	11	49	9	7	3087	FT897 + Verical, Inv L
W4JDS	ME	ALL	11	54	8	7	3024	FT817 + 20m hamstick
AE3J/3	DE	Low		41	10	7	2870	FT817 + 45ft remote tunable vertical
K9FO	IL	40		49	7	7	2401	Flex 1500 + Dipole
N8CX	OH	20/40		42	8	7	2352	HW8 + Dipole
VE3HG	ON	40	10	47	6	7	1974	
EA2AZ	Spain	High	7	34	7	7	1666	
KØMIS	CO	20	6	30	6	7	1260	K3 + End-Fed Wire
N8XX	MI	40		25	3	7	525	AT Sprint 33ft vertical
UU7JF	Ukraine	20	6	21	3	7	441	IC706
G4FDC		20	5	19	3	7	399	TS120V
VA3JFF	ON	20	2	10	2	7	140	FT817 + YP3 3ele Yagi
EA2BVV		20	1	2	1	7	14	Dipole

believe, the first ever contest outing for my aged but beloved Drake TR-5. I used an LDG QRP Autotuner between the TR-5 and an inverted-L antenna and kept the power below 5W. Keying was handled at first by my trusty E. F. Johnson hand key but early on I switched over to a K1EL K40 keyer with keyboard and Palm paddles. —**VE3EUR**

Difficult Band Conditions — **WB1HGA**

I continue to be amazed at what a half watt can do when you have motivated listeners. The stations were so jammed together that the entire contest was held in the bandwidth of one ssb signal. —**WV1N**

Enjoyed working 3 contests over the weekend (IA & IL QSO Parties plus this QRP one)! Used my K1 for all three events. There was activity on 40, 20, & 15. Good to see the sunspots coming back. It was great to work Guru, EA2IF—the only DX I heard. Had a fun time! — **WA8HSB**

Oct 16 operation was outdoor portable at St. Charles County Park with QRP club **—WB8EJN**

It was so good to hear the bands like 15 alive again. Been a long time since I made more than just a couple of contacts. **—W5TTE**

Portable at Delaware State Park, OH **—WD8RIF**

Very leisurely entry to support my status as a CPG (Contest Point Giver). But enjoyed hearing the buzz.15m was open but no one seemed to hear me there. Maybe next time. Hope the points help some of these ops! **—K4UPG**

Lots of QRM from other contests, particularly IL QSO party. Calling "CQ Test" was confusing. Better to call "CQ QRP". **—N9XO**

Good condx on 20m and no QRM. Sad to hear so many calling CQ who did not hear me answering. **—WA3SEE**

I operated from the Salt Marsh on the Delaware Bay at Woodland Beach Delaware. **—AE3J/3**

First contest with Flex 1500. Something New! Only 45 Minutes to operate dueto family reunion. See you in the Topband test. I will be VP9MFO **—K9FO**

Tested a new combination of rig, tuner, and antenna for this event. Had a ball—most of the contacts were inside the Illinois QSO Party, but snagged a couple folks other than these. **—N8XX**

Hard going. **—G4FDC**

Made a couple CW QSOs during JOTA to demonstrate the mode to the local Scouts. **—VA3JFF**

●●

Contest Announcements

2011 QRP-ARCI Spring QSO Party

Date/Time:

1200Z on 2 April 2011 through 2359Z on 3 April 2011. You may work a maximum of 24 hours of the 36 hour period.

Mode:

HF CW only.

Exchange:

Members send: RST, State/Province/Country, ARCI member number
Non-Members send: RST, State/Province/Country, Power Out

QSO Points:

Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:

SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:

>5 watts = x1
>1 - 5 watts = x7
>250 mW - 1 watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (also 7040 kHz for rock bound participants)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:

Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier.

Teams:

You may enter as a team with an unlimited number of operators as long as no more than 5 transmitters are on the air concurrently. You compete individually as well as on the team. Teams need not be in the same location. Team captains must send a list of members to the Contest Manager before the contest.

Categories:

Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m-160m)

Mulitoperator:

A multioperator effort may submit logs for a separate category. Any combination of operators and transmitters will be permitted. All transmitters must be located at a centralized location. All operators must use the same callsign in the multioperator category.

How to Participate:

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Log Submission:

Email Submission—Submit Logs in plain text format along with a summary stating your Callsign, Entry Category, Actual Power and Station Description along with score calculation to va3jff@yahoo.ca

Snail mail Submission—Submit Logs along with a summary stating your Callsign, Entry Categorym Actual Power and Station Description along with score calculation to:

ARCI Spring QSO Party
c/o Jeff Hetherington, VA3JFF
139 Elizabeth St. W.
Welland, Ontario
Canada L3C 4M3

Deadline:

Entries must be postmarked on or before 17 April 2011.

Results:

Will be published in *QRP Quarterly* and shown on the QRP-ARCI website, www.qrparci.org.

Certificates:

Will be awarded to the top scoring entrant in each category, as well as the top scoring entrants from each State, Province and Country. Certificates may be awarded for 2nd and 3rd place if entries are sufficient in a category.

2010 QRP-ARCI Hoot Owl Sprint

Date/Time:

8pm to Midnight LOCAL TIME on 29 May 2011.

Objective:

To test your ability to make contacts late into the evening local time.

Mode:

HF CW Only.

Exchange:

Members send: RST, State/Province/Country, ARCI member number
Non-Members send: RST, State/Province/Country, Power Out

QSO Points:

Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:

SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:

>5 watts = x1
>1 - 5 watts = x7
>250 mW - 1 watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (also 7040 kHz for rock bound participants)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:

Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier Bonus Points.

Bonus Points:

If you are operating PORTABLE using battery power AND a temporary antenna, add 5000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Categories:

Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m-160m)

How to Participate:

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Log Submission:

Email Submission—Submit Logs in plain text format along with a summary stating your Callsign, Entry Category, Actual Power and Station Description along with score calculation to contest@qrparci.org

Snail mail Submission—Submit Logs along with a summary stating your Callsign, Entry Category, Actual Power and Station Description along with score calculation to:

ARCI Hoot Owl Sprint
c/o Jeff Hetherington, VA3JFF
139 Elizabeth St. W.
Welland, Ontario
Canada L3C 4M3

Deadline:

Entries must be postmarked on or before 12 June 2011.

Results:

Will be published in *QRP Quarterly* and shown on the QRP-ARCI website, www.qrparci.org.

Certificates:

Will be awarded to the top scoring entrant in each category, as well as the top scoring entrants from each State, Province and Country. Certificates may be awarded for 2nd and 3rd place if entries are sufficient in a category.

2011 QRP-ARCI milliWatt Field Day Contest

Date/Time:

1800Z on June 25, 2011 through 2100Z on June 26, 2011.

Bands:

All bands (HF & VHF+) as outlined in the ARRL Field Day Rules
Exchange: Class/ARRL Section, per ARRL Field Day Rules

QSO Points:

CW=2 points/QSO, SSB=1 point/QSO, Digital=2 points per QSO

Multiplier:

Use the power multiplier for the HIGHEST power you used in the contest. Power Multiplier for all contacts:
>5W = X1
>1-5W = X7
>250mW - 1W = X10
>55mW - 250mW = X15
55mW or less = x20

Score:

Points (total for all bands) X Power Multiplier.

Bonus Points:

There are NO bonus point for this contest.

Categories:

(Class A) Club / non-club portable
(Class B) One or two person portable
(Class C) Mobile: Stations in vehicles capable of operating while in motion and normally operated in this manner
(Class D) Home stations: Stations operating from licensed station locations using commercial power
(Class E) Home stations - Emergency power
(Class F) Emergency Operations Centers (EOC)

Best reason to participate:

A fun mixed mode QRP contest and a chance to test/prove emergency preparedness.

Log Submission:

Entries should include a scoring summary, a copy of your log and a description of your station. Entries should be mailed to:

Jeff Hetherington - VA3JFF
QRP ARCI Contest Manager
139 Elizabeth St. W.
Welland, Ontario
Canada L3C 4M3

Email entries can be sent to: contest@qrparci.org

Deadline:

Deadline is 10 July 2011.

Results:

Will be published in *QRP Quarterly* and shown on the QRP-ARCI website, www.qrparci.org.

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http://www.qrparci.org/us2signup.html

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1540 Stonehaven
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